

THE PSYCHOLOGICAL BULLETIN

Joseph Peterson

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Professor Joseph Peterson died at Berkeley, California, on September 20, 1935, at the age of 57 years. He had an attack of influenza in the latter part of August but recovered sufficiently to attend the meetings of the A.P.A. at Ann Arbor, where he served as chairman at the presidential address and testimonial award. After the meetings he joined his wife in Chicago for a visit with relatives in Utah and Idaho, and then went to Berkeley to visit his son. There he suffered an attack of pleurisy, and this soon developed into a bronchial pneumonia which was responsible for his death.

Professor Peterson did a part of his undergraduate work in Utah and California, and then took his Bachelor's and Doctor's degrees at the University of Chicago where he was a student of Angell and Watson. According to President Angell, he revealed at this time all those qualities which later characterized his professional career. His instructors were impressed with his keenness and power of mind, his intellectual curiosity and integrity, and the tenacity with which he grappled with all difficulties until he had thoroughly mastered them. As a human being, he was modest, courteous, tolerant, considerate, and endowed with a peculiarly fine and fearless character.

After leaving Chicago, Professor Peterson taught 4 years at Brigham Young University, 4 years at the University of Utah, and 3 years at the University of Minnesota before going to George Peabody College, with which institution he has since been identified.

His reputation as one of the outstanding psychologists of the day is based primarily upon his work at Peabody. He was a stimulating and effective teacher. His laboratory soon became a recog-

nized center of scientific productivity and graduate training, and through his connection with the Southern Society he exerted a pronounced influence upon the teaching of psychology throughout the South.

It is needless to recount his scientific achievements and the honors attained in the psychological world. These are all well known to readers of this journal. It is his qualities as a man and a scientist that are of importance in a brief notice of this sort.

Professor Peterson achieved his recognition on the basis of sheer merit. He was not a self-seeker, and he never indulged in advertising and self-exploitation. He was an indefatigable worker—perhaps too much so for his own good. He had high intellectual and scientific standards and was never satisfied with poor and shoddy work on the part of himself or of others. He was intellectually honest with himself, and never indulged in any form of specious self-deception to attain quick and startling results. He approached all questions with a high degree of objectivity and impersonality of attitude. He evinced an uncompromising devotion to scientific ideals irrespective of its effect upon his personal fortune. In his early professional career he fought the fight for intellectual and scientific freedom, and paid the usual price—which he accepted without rancor, bitterness, or complaint. He was invariably sincere, courteous, kindly, friendly, and modestly unassuming in all social relations. While he was accustomed, in controversial discussions, to express his own beliefs with vigor and candor, and to subject the beliefs of his antagonists to severe intellectual scrutiny, yet he was essentially too considerate, tolerant, and fair-minded to indulge in personalities. Professor Peterson was a genuine man through and through, and his sterling qualities invariably elicited the respect and admiration of all who knew him. His untimely death is a source of deep regret throughout the psychological world.

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APPARENT MOVEMENT¹

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The present review covers the literature on apparent movement published during the last 5 years.² The field was last systematically reviewed for the *PSYCHOLOGICAL BULLETIN* by Squires³, in 1928, but the article by Ewert (14) on the perception of visible movement included most of the relevant publications on apparent movement during the period from 1928 to 1930. An excellent summary of both the experimental studies and the theoretical formulations concerning apparent movement which were published before 1930 will be found in Koffka's (38) article on the perception of movement.

In the following pages the term "apparent movement" will be considered as including not only stroboscopic movement, or the phi-phenomenon, but also a variety of phenomena such as autokinetic sensations and movement after-images in vision, and tactual, vibratory, and auditory illusory movement as well.

I. APPARATUS AND METHODOLOGY

Research Apparatus. The development of improved apparatus for research on stroboscopic movement has been briefly traced by Mibai (50). The most elaborate and accurate instruments used in recent work on this type of apparent movement were those employed by Waals and Roelofs (82), who used a modification of the Michotte tachistoscope, with 2 exposure discs having adjustable sectors. The exposure time of the stimulus objects could be regulated by adjusting the size of the sectors. Similarly, the pause between exposures could be systematically varied. Zero and negative pauses (*i.e.* partial overlap of the stimulations) were possible. Smoked glass was interposed to vary the light intensity, and color filters to

¹ The writer wishes to express his gratitude to Prof. W. R. Miles who kindly furnished reprints of articles otherwise inaccessible.

² Articles published before the period covered by the review will be cited in foot-note references, and they will not appear in the main bibliography.

³ Squires, P. C., Apparent Movement. *Psychol. Bull.*, 1928, 25, 245-260.

alter the hue. By adjustment of prisms the stimulus objects could be presented in any desired position.

A much simpler apparatus for experimentation with the phi-phenomenon was utilized by Mibai.⁴ Stimulus objects drawn with India ink on film were projected with an Eastman kodascope at the rate of about 18 frames per second. The pause between stimuli could be varied by using different numbers of blank frames between the exposures. Each section of film remained in position about 60 sigma. A rotating sector interrupted the projection and allowed the transition from one frame to the next to take place without blurring. The objection to this apparatus for precise experimental work is the fact that the stimuli are presented intermittently rather than continuously, and temporal values obtained are consequently difficult to interpret.

Demonstrational Units. Several instruments primarily designed for class demonstration of the phi-phenomenon have been built. Seward's (69) device consists essentially of a box in which are placed 2 lamps separated by a partition. A wooden screen which holds the slides is hinged to the front of the box. The pattern of apparent movement is determined by the arrangement of the cut-out figures on the slides. The method suggested for varying the intensity of the stimulation is to change the size of bulb used. The timing apparatus is a mercury-cup metronome. This device presumably allows one to alter the interval between exposures, but it would seem difficult to vary the exposure time independently. The Kelly-Miles (36) apparatus is more versatile. The front panel has mounted upon it 4 bulbs in a 15 cm. square. A fifth bulb is placed in the center of the square. A switch makes possible the flashing of either the horizontal or diagonal pairs separately. The interval between flashes, as well as the duration of the exposures, can be regulated by a make-break key. The introduction of the center light makes possible a large number of unusual patterns of apparent movement. An important feature of this apparatus is its portability, which permits, for example, the demonstrator to rotate the device until the horizontal lights become the vertical, while the subjects continue to maintain their fixation. Other instruments which may readily be adapted to the demonstration of apparent movement are those of Fröhlich (19) and of Geldreich (24). A motion picture demonstrating various types of apparent movement has recently been prepared by Metfessel and Joel (48a). Phi movement, beta movement, and other phenomena are demonstrated by the use of a clock dial with discs and figures.

⁴ When no identifying number follows the name of the investigator the reference is to the previously cited article of the author.

Stroboscopes. In the above devices apparent movement is obtained by presenting successively identical stimulus objects upon closely adjacent retinal areas. The stimuli themselves are stationary. The apparent movement obtained is customarily called "stroboscopic". The converse of this phenomenon occurs when moving objects appear stationary. The latter effect is likewise called "stroboscopic" and is produced by intermittent illumination of a rotating object, so timed that the object is always in the same position when illuminated. The instruments used for giving intermittent illumination to rotating objects to obtain this apparent stationary state are called "stroboscopes".

One highly developed instrument recently described by Bahls and Knowles (4) and by Quarles (66) is called the "Stroboglow". The device is portable. From it light flashes may be obtained at rates from 300 to 10,000 per minute. The high frequency interruptions are obtained from an oscillator circuit. A method of employing tuning forks and thyratron tubes as interrupters for stroboscopes is presented by Kluge (37).

The applications of stroboscopes are numerous (3). An essential feature of all instruments is a very low latency discharge tube for illumination. Utilization of neon type tubes for this purpose is suggested by Miles (52) and by Tiffin and Metfessel (79). Neon bulbs with 2 filaments allow one to illuminate 2 contiguous fields alternately, as in the Gaehr (20) two-field stroboscope. More accurate analyses of certain movements are made possible by this method.

Stroboscopic motion pictures, in which rapidly revolving objects are seen as if at a standstill, are obtainable by Edgerton's (13) technique. A mercury vapor discharge type, energized by a thyratron circuit, provides intermittent illumination of high intensity, permitting rapid, sharply-focussed pictures.

While most of the literature on the stroboscope deals with practical applications of the instrument in the industrial world, and must be omitted from our review because of lack of space, the article of Bartlett (5) was devoted to theoretical aspects of the stroboscopic method. The stationary patterns appearing on a rotating disc with alternate black and white sectors when it is illuminated by a source of light of periodically varying intensity were studied. Bartlett made a Fourier analysis of the disc and its illumination, deducing formulae for predicting the type of pattern and its relative intensity which would appear under different conditions. Actual observation confirmed the theoretical predictions.

Stroboscopic Analysis of Tones. A number of devices for the study of tonal phenomena have their origin in the stroboscope. The development of one such instrument, the "true tone analyzer" or "strobillion", is discussed by Farnsworth (15). The essential parts of the apparatus are a manometric flame and a rapidly revolving

disc with concentric bands of alternate black and white stripes. Singing into the megaphone causes the flame to flicker at a rate corresponding to the pitch of the tone. When the rate of this intermittent illumination synchronizes with the rate of presentation of the black and white stripes on the disc the latter appear stationary. The pitch of the tone can then be calculated mathematically. Farnsworth's improvement on the Scripture⁸ model consisted of the use of a wire wrapped around the burning point of the gas jet. The wire becomes hot during the operation of the instrument and relights the gas whenever too great voice pressure makes this necessary. An advance over the "strobilion" was developed by Anderson and Lowery (1) who substitute for the gas flame a neon bulb energized by the output of a microphone amplifier circuit. This device is similar to that of Ferreri and Terruzzi (17).

Metfessel and Musgrave (49) use the beams reflected from a mirror mounted on a loud speaker unit in place of a discharge tube. Greater flexibility may be obtained by this method. An analysis of the apparent movement produced in this way is made by Warren (84). The difference between the Metfessel method and the traditional ways of producing stroboscopic movement is discussed. Another method of producing the apparent stationary state of the tonoscope disc is described by Metfessel (47). The eye itself is made to vibrate at rates which correspond to the speed of rotation of the disc. A mechanical vibrator is pressed against the head, although some individuals may obtain the effect by singing at the proper pitch, the vibration being transmitted to the eye by bone conduction. The amount of movement of the retina need not be very great (0.2 mm.). While most of the work so far described has been devoted to using the stroboscope for determination of the fundamental notes, the same technique can be applied in studying the harmonics of tones (Nemes, 57).

The use of the method upon which the stroboscope operates for obtaining photographic records of pitch changes is suggested by Metfessel (46). The device which he developed for this purpose he calls the "strobophotograph". His technique has been successfully applied in the recording of bird singing (Metfessel, 48). The "Phonogammoscope" of Doniselli (10) has similar applications.

Clinical Applications of the Stroboscope. The stroboscope has been extensively applied in laryngoscopic examination. By interrupting the light of the illuminating instrument at the proper rate the vocal cords may be made to appear stationary during examination. An improved apparatus for this purpose is described by Kallen and Polin (33). The device employs a microphone circuit, an amplifier, and a gaseous discharge tube. By this arrangement the rate of

⁸ Scripture, E. W., *Das Strobilion: Ein Apparat zur Sichtbarmachung der Tonhöhe der Stimme. Zsch. f. Psychol.*, 1928, 59, 166-169.

the vocal cords and the number of interruptions of the light may be kept in constant synchronization. The vocal cords may then be studied in any portion of their cycle.

Stern (72) presents clinical findings upon 2 patients where the motility of the vocal cords appeared normal in laryngoscopic examination, but where stroboscopic analysis revealed the fact that one of the vocal cords remained stationary during the singing of certain notes. He develops (72) and elaborates (73) a formula for the rate of vibration of the vocal cords. Situations in which changes in the vibration rate take place are discussed. Weiss (86) criticizes Stern's interpretations by pointing out that the vocal cord need not have been stationary in Stern's patients, since the appearance of being stationary is also obtained in stroboscopic work when the stroboscope has the same frequency as the vocal cord, or where the difference between the frequency of the cord and that of the stroboscope is 10-12 oscillations. The difference in the frequency of the 2 cords might then be expected to make one appear stationary and the other moving when examined stroboscopically. Stern (74) avers that Weiss' theoretical argument in no way invalidates his own contention that there is a lack of correspondence between the laryngoscopic and stroboscopic findings. Weiss (87) presents further arguments concerning the impossibility of the vocal cords being stationary during singing when air currents invariably move the cords to some extent. Stern's contributions are discussed and evaluated by Maljutin (43). He refutes Weiss' statement that stroboscopy is an optical illusion and points out that its value is great clinically and that it is a "lawful optical phenomenon".⁶ In later articles Stern (75,76) discusses further the phenomena of the stroboscope as applied to the diagnosis of vocal cord degeneration and suggests apparatus for photo-stroboscopic recording of vocal cord movement in disease.

New Methods of Obtaining Miscellaneous Apparent Movement Phenomena. A simple procedure for producing a striking type of apparent movement is presented by Bousfield and Barry (8). A washer is fitted over a spirally striped cylinder. Rotation produces the appearance of movement of the washer along the axis of the cylinder. A peculiar type of movement, which occurs when a spiral formed of joined quarter circles having the same tangents at their point of junction is revolved, is reported by Dufour and Donzelot (11). During the resting state the spiral appears very regular, but when turned, some parts appear more convex than the neighboring parts, and this appearance changes until, at greater speeds, it presents the aspect of a polygonal line which turns. Interesting patterns of apparent movement in Lissajou figures were observed by Weber (85). Two tuning forks, one mounted vertically and the other horizontally, are used to obtain this illusion of motion. A

⁶ P. 1362.

beam of light is reflected from a mirror mounted on the first to a mirror on the second and thence to the screen. Complicated patterns are perceived in constantly changing relationships.

Apparent movement resulting from the observation of the silhouette of a revolving fan is described by Miles (53). A small two-blade fan propellor is placed behind a milk-glass window and illuminated in such a way that the silhouette of the fan in motion is cast upon the window. Interpretations of the movement as "revolving", "stretching", "clapping", "oscillating" and "crossing" were obtained. The order of occurrence was approximately that in which the types of movement are named. Miles (54) also reports apparent movement with neon lights mounted in the form of a square with diagonal pairs flashing alternately. Alternation between a double swinging pendulum and a see-saw figure was observed. In some cases a circular clockwise or counter-clockwise figure is obtained.

The use of the phi-phenomenon as a test of lateral dominance is suggested by Raney (67).

Two lights are "so arranged that conditions for the perception of phi movement are simultaneously presented to both eyes. The areas stimulated at near fixation are, in the right eye, such as involve primarily the left hemisphere, and in the left eye the right hemisphere; at far fixation in the right eye, the right hemisphere is involved and in the left eye, the left hemisphere. Reported direction of movement is assumed, on the basis of correlation with other tests of lateral dominance, to indicate a dominant functioning of the area stimulated."¹

Two distinct types of apparent movement which can be obtained by altering physical conditions are described by Fernberger (16). Two figures were placed on each of 2 test cards tachistoscopically exposed so that they appeared on the same field. With one set of conditions an apparent movement of the 2 lines in a parallel direction was obtained, while with other conditions the one figure remained stationary and the other appeared to cross it. The greater the differentiation of the 2 figures the more frequently was the second type of movement obtained.

The vehicle illusion, a type of apparent movement in which one attributes movement to his own conveyance when an adjacent vehicle begins to move slowly, was observed to occur in the vertical direction by Miles (51). The apparent movement experience was found to occur in ferries and in elevators. The differences in the conditions of vertical and horizontal vehicle illusions are discussed. Another

¹ P. 740.

movement, illusion, frequently called the "panorama illusion", in which objects seen from a moving vehicle appear to be moving in an opposite direction, was investigated by Angyal (2). Under certain conditions, the author points out, external objects may seem to move in the same direction as the observer, and lines perpendicular to the wheels seem to move with a rotary motion.

II. EXPERIMENTAL STUDIES

Experimental investigations have been made during the last 5 years of each of the principal types of apparent movement described by Parsons⁸: (1) apparent movement when, with the objects stationary, the head or eyes are moved without a corresponding compensation of egocentric localization; (2) after-image movement, when eyes and head remain stationary; and (3) stroboscopic movement, either when identical images of an object fall rapidly in succession upon very closely neighboring retinal spots, as in the usual phi-phenomenon, or when slightly different images fall rapidly in succession upon the same spot, as in motion pictures. Experimental studies have also been made of tactual, vibratory, and auditory apparent movement.

A. VISUAL APPARENT MOVEMENT

(a) *The Autokinetic Sensation.* As representative of the first class of apparent movement phenomena is the Charpentier⁹ illusion, the so-called "autokinetic sensation", in which a luminous point fixated in darkness appears, after a short time, to be moving. Björkman (6) used 19 subjects in his investigation, 17 with direct fixation and 2 with indirect vision. No relation could be observed between the direction of the entoptic after-image movement and the direction of the movement of the weak light fixated in darkness. The apparent movements of the light were variable, being either continuous or saccadic and either to the left or to the right. The interesting history of the autokinetic sensation will be found in Hovland's (31) review of earlier work.

(b) *After-Images of Movement.* The second type of apparent movement is typified by movement after-images. Sturm (77) chal-

⁸ Parsons, J. H., *An Introduction to the Theory of Perception*. New York: The Macmillan Company, 1927.

⁹ Charpentier, A., Sur une illusion visuelle. *Comptes rendus hebdomadaires de l'Académie des sciences*, 1886, 102, 1155-1157.

lenged the statement of Hunter¹⁰ that "It is the apparent direction of the real movement and not the actual direction which determines the after-movement".¹¹ Sturm's experiments demonstrate that the Hunter effect is often observed, but that even under unambiguous conditions of original perception 'opposite', 'resultant', and 'alternate' effects are frequently found.

Gates (23) investigated movement after-images with monocular and binocular, direct and indirect vision, using a rotating spiral disc. Four distinct types of movement were reported by her subjects: (1) rotary movement, (2) expansion and contraction, (3) approach and withdrawal, and (4) movement of the spiral lines toward either the periphery or the center of the disc. The third type of movement was predominant, but large individual differences were found. An interesting observation was that when identical discs, spatially separated and rotating in opposite directions, are presented to the 2 eyes separately, the after-effect is an opposing movement of the 2 discs, one toward and the other away from the observer.

The experiments of Durup (12) were devised to separate the effects of "retinal" and "field" after-movement. By having his subjects read a text on a moving surface he got "field" after-movements with a minimum of "retinal" components. After-movement was studied when "projected", i.e. observed on a bright surface, and when "retinal", i.e. observed in the dark. A marked difference between these 2 types of after-movement is indicated by Durup's finding that the maximal duration of the after-effect is obtained for "projected" images when the stimulating movement is at the rate of 14-17 cm. per second, but that the maximal "retinal" after-movement is obtained with movement of 1-4 cm. per second. A recent study of the negative after-image of movement is reported by Gutmann (26). The effects of variations in the amount of illumination, exposure time, and degree of expansion of a revolving ring sector were investigated. Both normal subjects and Eidetikers were employed.

(c) *Stroboscopic Movement.* One of the outstanding examples of experimentation upon this type of apparent movement is the work of Waals and Roelofs (82).

These writers systematically varied the pause between stimuli from high positive values through zero to negative values (in which the 2 stimuli are

¹⁰ Hunter, W. S., The After-Effect of Visual Motion. *Psychol. Rev.*, 1914, 21, 245-277.

¹¹ P. 257.

simultaneously present part of the time). Ideal movement was obtained at small positive, zero, and small negative pauses. The authors believe the pause to be of slight significance for apparent movement, but attach considerable importance to the exposure time. The effects of various fixation points were also investigated. When the stimuli were placed at a short distance movement was seen more consistently without a fixation, but with stimuli at a great distance, movement was seen more consistently with fixation.

The phenomena of apparent movement have been entirely reclassified by Waals and Roelofs. For the apparent movement to be ideal, or optimal, they demand that the constituent lines lose their identity completely, the first line appearing without wavering, moving across to the second position and there remaining steady until it disappears. Two new forms of movement are distinguished. When the 2 lines do not disappear simultaneously, but the line which disappears first appears to move in the direction of the second line they call the movement "*Erlöschbewegung*". When the second line is presented while the first remains and the second appears to come from the region of the first the phenomenon is called "*Auftauchbewegung*".

Mibai (50) attaches considerable importance to the pause: "The length of the pause between exposures influences the type of motion reported, although on occasion any type of movement may be seen with any pause."¹²

Continuous movement was most frequently observed at intervals of pause of 70 and 130 sigma.¹³ Succession without apparent movement is dominant when the pauses are 250 sigma and universal when they are 310 sigma. A striking phenomenon was observed when the angle made by the 2 lines of the pattern was greater than 90°. The movement is not confined then to a two-dimensional plane, but the line appears to describe a cone in 3 dimensions. Rotary movement, which is frequently observed in the rotation of aeroplane propellers, for example, when the movement appears to be in a direction opposite to the real movement, was also studied. The research indicated that there exist "indifferent areas, which are situated about the middle of the spaces between neighboring spokes. When the spokes fall on these areas in the succeeding exposure the movement of the wheel is observed as fluctuating. When they fall on the space between the original positions and these areas the rotation is clockwise, and when they fall beyond these areas it is seen as counter-clockwise rotation."¹⁴

The importance of the duration of the stimuli and the rôle of the pause between successive stimulus members are stressed by

¹² P. 86.

¹³ We have previously described Mibai's apparatus (see above, p. 756). With her apparatus no intermediate pauses could be obtained, because 60 sigma was the time required for the interpolation of one additional blank frame of film.

¹⁴ P. 88.

Neuhaus (58). The length of exposure of the first stimulus light was observed to be much more important than that of the second. The time between the exposures may be shortened in proportion to the decrease between the stimulus objects. Optimal movement appeared with shorter and shorter pauses the longer the exposition time. The possibility, however, that the sum of the exposition time and the exposure time is a constant, was definitely disproved.

Study was made by Steinig (71) of the "intermediate" types of movement which have been reported in apparent movement researches. The conditions under which "bimembral" (the first object moves a part way toward the second object and disappears; then the second object appears below that point and moves into its end-position), "unimembral" (only one object moves, while the other remains in its place), and "intramembral" (the objects do not exchange places, but have movement within themselves) movements occur were investigated. The degree of complication and the significance of the stimulus objects were found to be the most important determinants of the type of movement reported.

The problem of the importance of background illumination for apparent movement was attacked by Flug (7). Illumination contrast produced enhancement of the phenomenon (1) in still pictures with movement indicated, (2) in the transition from one phase to the other in Müller-Lyer figures (Alpha movement), (3) in the contrast movement of Ehrenstein¹⁸, and (4) when several different apparent movements were produced simultaneously in the same field.

What determines the direction of movement when several possible alternatives are presented was the subject of the investigation of Schiller (68). The alternative is chosen which completes the movement by the shortest path and in such a way that the simplest possible figure results. These factors are labelled "tendency toward the simplest path" and "tendency toward total assimilation". The temporal factors seem to be of little significance.

Squires (70) has reported an experiment on "colored movement". The typical phi-phenomenon set-up was used, but the stimuli were colored lights which were sometimes antagonistic and sometimes complementary in hue. Movement was reported in 83% of the exposures, colored movement in 72%. Movement was found to be 'good' even when the stimulus members were of different hue.

¹⁸ Ehrenstein, W., Versuche über die Beziehungen zwischen Bewegungs- und Gestaltwahrnehmung. *Zsch. f. Psychol.*, 1925, 96, 305-352.

The partial movements were more common when the stimuli were of different colors, particularly when the hues were non-complementary. Little relationship between the hue combination and the pattern of movement could be observed.

(d) *Gamma Movement*. Harrower (27) and Newman (61) have studied the type of apparent movement in which the illuminated figure expands upon presentation (Gamma movement). Harrower's work was done in response to Engel's¹⁶ assertion that γ -movement is not an intrinsic phenomenon determined by the properties of the figure as such, but only part of a general law which states that the change of brightness in the field which accompanies the appearance and disappearance of a figure conditions the expansion and contraction that is observed as a movement of the figure itself. Harrower's work indicates, however, that this thesis cannot be maintained, since a black figure appears with expansion and a white one disappears with contraction, despite the increase in the field intensity. Temporal factors were varied by Newman. Under 50 sigma the transition time has no effect upon the phenomenon, but over 50 sigma a regular series of developmental stages occur.

(e) *"Induced" Movement*. The technique of Duncker¹⁷ has been employed by Krolik (40) and by Oppenheimer (62) in the study of "induced" movement, i.e. apparent movement where the objective stimulus remains stationary and the experienced movement is due to a shift of the surrounding objects or the observer. Krolik used as figures pictures of actual objects which the subjects had previously experienced as moving or as being at rest. Evidence is presented by Oppenheimer that movement is induced (1) in an object which undergoes change, (2) in the less intense object, (3) in the smaller of 2 objects, and (4) in the horizontal rather than the vertical of 2 lines.

B. AUDITORY APPARENT MOVEMENT

The illusory movement of sound sources was the subject of research of Mathiesen (44). No compulsory conditions for apparent movement were found. Only 4% of her 6,000 trials resulted in

¹⁶ Engel, P., Untersuchungen über die Wahrnehmung der Bewegung durch das Auge (F. Schumann, Ed.) III. Tachistoskopische Expositionen und Scheinbewegungen. *Zsch. f. Psychol.*, 1928, 107, 273-313.

¹⁷ Duncker, K., Über induzierte Bewegung (Ein Beitrag zur Theorie optisch wahrgenommener Bewegung). *Psychol. Forsch.*, 1929, 12, 180-259.

reports of movement. While a naïve attitude on the part of the subject has been found to be most favorable for the appearance of visual apparent movement, Mathiesen found the analytical attitude superior in audition. Certain types of dichotic hearing were found to be the most favorable for movement phenomena. Hisata (30) was able to produce all the phenomena characteristic of visual apparent movement in sound. Succession, part movement, and optimal movement could be produced under proper temporal and spatial conditions. The "pure phi" was also observed.

C. TACTUAL APPARENT MOVEMENT

Recent investigators of tactual apparent movement are Mokuno (56), Neuhaus (59), and Tschlenoff (80). Neuhaus has sought to determine the rôle played by the time interval between applications of the stimuli, the spatial distance between them and their duration. Illusory movement was found to occur with time intervals from 0 to 500 sigma. If the temporal interval is progressively shortened the distance between the stimulated points must also be shortened, as in visual apparent movement. With a constant distance, either relatively short or relatively long stimulations are superior. A graded series of intermediate types of movement was found from succession to simultaneity including movement in an arc, movement in an ellipse, and finally movement in a straight line. The speed of the apparent movement is proportional to the temporal interval. Tschlenoff also found these movement types: single movement, double movement, and movement on, over, and under the skin all being observed.

D. VIBRATORY APPARENT MOVEMENT

Apparent movement in the vibratory sense, a type of movement heretofore unreported, was observed by Thiel (78). Two vibrating units energized by a microphone amplifier were used, one for each hand. Protocols from 8 subjects indicate that apparent movement was universally observed. Later one vibrator was used for the hand and one for the foot. Apparent movement from the region of the hand to the foot, or in the other direction, depending upon the order of presentation of the stimulation, was easily produced. Regular alternation movement was perceived when a metronome beating 126 times per minute was employed.

E. APPARENT MOVEMENT WITH STIMULATION OF
SEVERAL SENSES

Galli (21, 22) has tried to combine various types of stimuli to produce apparent movement. Visual, tactual, and auditory stimuli were presented in various combinations. When the time intervals between the various stimuli were too long or the distance too great, succession was observed. Rapid presentation resulted in the appearance of simultaneity. At an optimal point in the temporal and spatial relations, however, apparent movement is produced. One sense appears to act as the carrier of the movement. Of the three types of stimuli the visual predominantly assumes the rôle of carrier. In the absence of visual stimuli the tactual stimulus assumes this rôle. Audition is rarely the sense which predominates as the vehicle of apparent movement.

III. THEORETICAL FORMULATIONS

While there have been some attempts to embrace all of the phenomena of apparent movement in one comprehensive theoretical system, for the most part theories have been developed to explain specific types of apparent movement. Consequently there are theories of autokinetic sensations, theories of movement after-images, theories of stroboscopic movement, and the like. This situation has been almost inevitable since individuals investigating single types of movement are solely interested in explaining the type which they have reported.

The Autokinetic Sensation. Göthlin (6) explains the Charpentier illusion (the autokinetic sensation) on the basis of a differential rate of fatiguing of the different vector groups of the external eye muscles which are effective in fixation. In order to maintain fixation, consequently, the fatigued group must be more strongly innervated. The increased motor influxes cause an impression of movement in a direction conditioned by the muscle group which is the most fatigued.

Movement After-Images. Sturm (77) believes that four principal factors account for movement after-images: (1) "the reversal of the processes occurring during the observation of the original movement"; (2) "the field condition during the observation of the after-movement"; (3) "the anisotropy of our visual space, with its preponderance of the vertical direction"; and (4) "the influence

exerted by the form of the motion carrier on the direction of the movement" . . . "Of the four factors only the first represents a real force, while all the others are systematic conditions constraining the freedom of the movement."¹⁸ Gates (23) divides all theories of movement after-images into 2 groups: (1) central theories, which hold that the phenomena are due principally to processes within the central nervous system; and (2) peripheral theories, which hold the phenomena to be predominantly retinal or muscular in origin. Gates' theory is largely of the latter variety. She writes:

"During the observation of the objective movement the continued stimulation of the eyes by the rotation of the disks sets up certain very definite changes in the tonus of the eye-muscles. These changes probably occur both in the external muscles, and, more especially, in the internal muscular systems of the mechanisms of accommodation and convergence. Upon cessation of the movement . . . these well established changes are completely upset. The stimulus-situation which created them is suddenly removed, and the return of the muscles involved to their normal state at once begins. Those muscles in which an increase in tonus had occurred now gradually relax, those in which the tonus was correspondingly decreased now return to their former state of greater tonicity. This adjustment, of course, involves activity of the central nervous system. The result perceptually is an experience, only part of which is determined by activities initiated in the retina."¹⁹

This is closely akin to Langfeld's (42) formulation of his motor theory:

"Inasmuch as the response theory does not call for actual movement but merely a specific change in the efferent system, it is possible that a change in muscle tonus produced by the antagonism of the muscles involved is a physiological cause of such phenomena." Furthermore the movements need not "be restricted to the eye-muscles, but . . . any other response might, under certain circumstances, be conditioned to the visual stimulus."²⁰

Grindley (25) put to experimental test the theory of Granit²¹ that movement after-images may be explained as due to the inhibitory action of the rods upon the activity of the cones. If this be true red light, which stimulates chiefly cones, should have a different after-effect than would blue or violet which stimulates cones only very slightly but rods strongly. The after-effect was measured for 2 different areas. The light from a moving object stimulated first

¹⁸ Pp. 292-293.

¹⁹ P. 45.

²⁰ Pp. 101-102.

²¹ Granit, R., On Inhibition in the After-Effect of Seen Movement. *Brit. J. Psychol.*, 1928, 19, 147-157.

only the rod free area, and later a larger area. "No evidence of inhibition was found, and it is suggested that Granit's results must be explained in some other way."²²

Stroboscopic Movement. Good reviews of current theories of apparent movement of the stroboscopic variety are to be found in Waals and Roelofs (82) and in Neuhaus (58). Waals and Roelofs assume the existence of a certain psychophysical process which rises and wanes in strength and manifests itself subjectively in brightness.

The psychophysical process of the first stimulus decreases after the stimulation ceases, and the psychophysical process of the second stimulus influences the localization of the first stimulus during the period when the subjective brightness of the first stimulus is quickly waning. In their explanation of apparent movement the importance of the perception time ("Wahrnehmungszeit") and perception duration ("Wahrnehmungsdauer") is stressed. Ideal movement for them is a complicated interactivity of two more elementary types of movement, "Erlöschbewegung" and "Auftauchbewegung".²³

Neuhaus (60) rejects current physiological theories for apparent movement phenomena.

"Apparent movements are of a psychological nature." Among the facts which he adduces for this statement are "(1) Apparent movements being basically acts of apprehension; (2) the transformations which are to be observed in complicated stimulus complexes; (3) the dependency of these transformations upon the will, 'set' and attention; (4) the fact that the object can be seen in a field of movement; (5) the inadequacy of stimulus conditions to explain apparent movement phenomena."²⁴

The formerly widely accepted short-circuit theory of Wertheimer²⁵ has been subjected to considerable criticism. In his critical analysis of the Gestalt theories of perception of apparent movement Petermann (63, 64) finds the theory in its original formulation untenable, since it fails to explain any but the simplest types of movement. Neuhaus (58) concludes from his researches that "A series of psychological and physiological considerations argue against the short-circuit theory".²⁶ Neuhaus (60) points out as evidence against the short-circuit theory the fact that the pure phi is only observed with practice and is not the elemental experience

²² P. 59.

²³ See above, p. 763.

²⁴ P. 395.

²⁵ Wertheimer, M., *Experimentelle Studien über das Sehen von Bewegung*. *Zsch. f. Psychol.*, 1912, 61, 161-265.

²⁶ P. 457.

Wertheimer had claimed. Neuhaus' argument is sustained by the recent work of Kelly (35) who found that whereas only 50% of his subjects saw apparent movement spontaneously, 94% saw it after being told what to look for. Neuhaus also brings up the point that visual and tactual apparent movement often appear to take a curved path and not, as Neuhaus believes a short circuit theory would require, a straight line. Fröhlich's (18) "physiological fusion" theory ("physiologische Verschmelzungstheorie") is also criticized by Neuhaus on physiological and psychological grounds.

Piéron (65) believes he has convincing refutation of the short-circuit theory. He presented the image of a bird in flight to one eye and a later phase of the movement to the other after an 150 sigma pause and obtained apparent movement. He summarizes his findings thus: "In any case there is no doubt about the existence of the perception of apparent movement, but all basis for the hypothesis of a short-circuit is removed."²⁷ The reviewer believes that this evidence will fail to convince Gestalt proponents of the failure of their theory, since short-circuiting might readily be expected to occur from one portion of a hemisphere to the corresponding portion of the opposite hemisphere.

The problem of whether or not there is a "pure phi" is still debated. It is Waals and Roelofs' (82) contention that there is no "pure phi", i.e. movement without an object, but that in true optimal movement one really sees the object cross the field. Discrepancies of results are attributed to defective working conditions and over-short exposures so that some investigators have never seen true optimal movement. Squires (70) found that some vehicle of movement was required to explain his colored movement: "If the Gestalt-Theorie in the field of apparent visual movement is presumed to depend upon the proposition that quality of movement is 'cut away from', or relatively independent of, the quality of the stimulus, then this theory is without firm foundation."²⁸

Dimmick's²⁹ concept of the "gray flash" has also met violent criticism. At least for colored movement, states Squires (70), the "gray flash" is not the essence of apparent movement. Blug (7) obtained the "gray flash" only when the brightness of the object field differed from that of the tachistoscopic field.

Explanations of stroboscopic apparent movement on the basis of

²⁷ P. 248.

²⁸ P. 64.

²⁹ Dimmick, F. L., An Experimental Study of Visual Movement and the Phi Phenomenon. *Amer. J. Psychol.*, 1920, 31, 317-332.

eye-movements have become less common with the increasing mass of experimental evidence.

Hulin and Katz (32) have supported the observations of Guilford and Helson⁸⁰ and others that eye-movements and appearance of apparent movement have no correlation: "Photographic records, taken of the eye-movements during the successive presentation of two lights, indicate that the eyes do not move as often during the experience of phenomenal movement as during the intervals when movement is not perceived."⁸¹

The problem of the relative importance of the objective stimulus pattern as compared to the subjective attitude has been continuously debated in print. Fernberger (16) states that he is able to get whatever type of apparent movement he wishes by altering the physical conditions. His findings seem to him strong confirmation of the "constancy hypothesis" of Gestalt theory in respect to the relation between the physical and phenomenal patterns. Weber (85), on the other hand, states: "The primary indication of these results is to contradict the view of illusory motion which seeks its complete determination in objective terms, leaving out of account such factors as the direction of attention, instruction, attitude. Within limits, one sees what one *intends* to see."⁸²

The same point is brought out in the statement of Squires (70) that: "All the evidence converges, 'beyond a reasonable doubt', to the conclusion that mental set or attitude is of primary importance",⁸³ and that of Piéron (65) that "The rôle of the perceptual attitude is essential".⁸⁴ Miles (54) has demonstrated how under identical stimulus situations individual subjects obtain quite different impressions of apparent movement, dependent upon their set and attitude.

Kelly (35) gives evidence concerning the importance of attitude in determining the type of apparent movement when he reports that, when a pattern movement with two possible interpretations was shown, the first perceptual experience of 95% of a naïve group was determined by suggestion of the movement which would be seen, although practically all saw both patterns later.

The possibility that the difference in the perceptual attitudes of adults and children might cause them to experience apparent move-

⁸⁰ Guilford, J. P., and Helson, H., Eye-Movements and the Phi-Phenomenon. *Amer. J. Psychol.*, 1929, 41, 595-606.

⁸¹ P. 332.

⁸² P. 649.

⁸³ P. 64.

⁸⁴ P. 246.

ment under different conditions was investigated by Meili and Tobler (45). But children perceived the apparent movement under the same conditions as did adults, although children could perceive it with longer pauses. The slight difference found was attributed to the greater ease of creation of "processes of the whole" in children than in adults. Miles (55), likewise, could find no reliable difference in the perception of apparent movement which correlated with age.

The relationship between real and apparent movement has been the subject of considerable interest. Hertz (29) states as her theory that the perception of movement can be explained on the basis of the asymmetry of retinal excitation at any one time during movement of the image across it. Stroboscopic effects are explained on the same basis, the total pattern of excitation being a result of successive eccentric stimulation similar to the pattern of excitation due to actual movement. This resembles the explanation given by Karrer and Stevens (34) who postulate a spatial gradient of retinal excitement.

On the basis of experimentation Waals and Roelofs (83) come to the conclusion that real and apparent movement are one: "On the basis of these results we come to the conclusion that the seeing of real movement is exactly identical to visual apparent movement."²⁵ The grounds for the belief are cited and the work of other investigators reviewed. Neuhaus (58), on the contrary, after citing a number of differences between real movement and apparent movement, comes to the conclusion that: "The adduced facts must be enough to show that a theory of movement cannot be built upon apparent movement."²⁶ This discrepancy is accounted for by Hartson (28) on the basis of the fact that movements are of three types (fixation, tense, and ballistic), but that apparent movements are marked by those characteristics peculiar to but one of these types, viz., the ballistic or momentum movement. Evidence is adduced to show the similarity in the behavior of apparent movements and ballistic movements with respect to speed, direction, and other characteristics.

An excellent study which bears upon the relationship between real and apparent movement is reported by Brown (9). He sought to find out if factors which influence phenomenal velocity also influence apparent movement. He predicted from the known facts concerning phenomenal velocity the threshold of appearance of appar-

²⁵ P. 342.

²⁶ P. 449.

ent movement, and then in the laboratory he performed experiments to test his hypotheses that: "All changes in field structure that influence phenomenal velocity also influence the production of apparent movement, and influence it by amounts that, from the work on apparent velocity, allow easy calculation. . . . The thesis that the underlying physiological processes for both real and apparent movement are of the same nature is essentially correct and hence the explanation of one fact will also bring about the explanation of the other."³⁷ The actual thresholds obtained agreed very closely with his predictions. The reviewer considers such studies as this one distinctly promising for the future development of sound theory. Theories which can be tested in the laboratory will doubtless prove more fruitful than those of the arm-chair variety.

Gamma Movement. Harrower (27) has adduced evidence to show that the brightness changes in the "ground" are not the factors responsible for Gamma movement. Her conclusion is: "The main determinants of γ -movement are in the relation of figure to ground, and not those of change of brightness."³⁸ Further discussion of the theoretical basis of Gamma movement is found in Koffka's (39) article on the psychology of visual perception.

Induced Movement. According to Krolik (40) experience is an important determiner of induced movement. The effect of experience is not to be deduced from fixation and eye movement but from Duncker's "law of movement distribution". The factors which influence induced movement are: (1) a tendency to unity of the system of reference, (2) a tendency to centralization of the system of reference, (3) a tendency to conservation of the reference relationship.

Tactual Apparent Movement. While there has been little attention paid to the theory of auditory and vibratory apparent movement, theoretical analysis has been undertaken for tactual movement. Tschlenoff's (80) theory that tactual apparent movement is the result of certain nervous derangements is reminiscent of Head's³⁹ statement that the translation of contact into a sensation of movement is one of the very striking consequences of disturbance in the sensory cortex. Tschlenoff reports "high" correlations (between $+.33$ and $+.65$) with perceptual inadequacies and with nervous diseases. Neuhaus (59), who has made a very careful comparison of the

³⁷ P. 256.

³⁸ P. 63.

³⁹ Head, H., Sensation and the Cerebral Cortex. *Brain*, 1918, 41, 57-253.

nature of visual and of tactual apparent movement, comes to no such conclusion. He holds to a "psychological" theory and carefully marshals evidence in support of it.

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CIRCUITS NOW AVAILABLE FOR THE MEASUREMENT OF ELECTRODERMAL RESPONSES

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The neophyte in the field of the measurement of electrodermal responses¹ who wishes to use this tool in a psychological investigation finds in the literature a number of devices whose claims of superiority require comparative evaluation. Few of them state their limitations and as a result the experimenter in this field may be puzzled as to what apparatus will adequately meet his requirements. In the following paragraphs we shall consider some of the improved circuits of the present day that have found general usage or show promise of further development. Description will be limited as nearly as possible to pointing out the distinctive features of each circuit or apparatus.

The methods used by earlier investigators of this phenomenon have been described rather briefly by Landis and DeWick (20) and Landis (21) who at the end of their articles give references to other summaries of apparatus and a large general bibliography. Interest in many of these devices is now chiefly historical.

One technical difficulty unrecognized by early workers caught the attention of present investigators and led to the designing of elaborate measuring circuits and electrodes. This factor is vaguely captioned 'polarization' and is used by some workers to explain all results which do not fit their expectations. A clearer understanding of the term is essential in selecting the apparatus with which one wishes to work. Polarization in itself is a theoretical concept borrowed by the physiologists from the chemists and physicists, and amplified to meet their demands. When an electric current passes through a solution the ions of the solute, each of which bears a positive or negative charge, are attracted to their complementary poles or are polarized. The tissue-cells of the sweat-glands form a

¹ The need for a change from the term *psychogalvanic reflex* has been mentioned by Ruckmick (31) and Bentley (1). The former has suggested the phrase *electrodermal response* as being more descriptive. Ruckmick's terminology is used in this paper.

type of such solution. In addition, their formation enables them to possess a capacity effect similar to a miniature condenser. McClendon (24) called this 'polarization capacity'. Gildemeister (13, 14) showed that polarization capacity is equivalent to capacity in parallel with resistance and is similar to the effect of a leaky condenser. He demonstrated the fact that both the apparent change in resistance of the bodily tissues to a current from the outside and the apparent electrical output of the body are explainable in terms of a polarization theory. The relation of this theory to other physiological data and the present views on the matter have been briefly summarized by Landis (22). It is now believed that the electrodermal response obtained, either by endosomatic or exosomatic (see below) measurement, is due to some polarization effect of bodily tissue, particularly in the sweat-glands, plus actual tissue resistance. The responses measured by either procedure are very similar save that the exosomatic current gives the larger deflections.

It is convenient to distinguish clearly between polarization of the electrodes which make contact with the skin and polarization of bodily tissues themselves. The two tend to operate together in every circuit and are confused at times in the literature. Thus polarization within the contact of bodily tissues and the electrodes is to be avoided as much as possible while the latter is merely a theoretical physiological explanation of the observed phenomena.

All electrodes are liquid in principle when one remembers that the response is accompanied, as Darrow (4, 5) has shown, by a secretion of sweat. To avoid the polarization which would result when a current passed through them, elaborate 'liquid' electrodes have been devised. These involve the use of physiological salt solutions, in which the sweat may be dissolved, applied to the skin in various ways. Landis (19) reported that all of a number of 'non-polarizable' electrodes which he studied by means of the salt-bridge method, were polarizable. The difficulty has been better avoided through the use of improved electrical circuits.

Endosomatic Measurement. It is customary to consider the phenomena relating to the electrodermal response under the headings *endosomatic* (no outside source of current used) and *exosomatic* (outside potential applied). Tarchanoff (33) called attention to the first type of measurement. He connected his subject directly to a sensitive galvanometer and read changes in the output currents of the body in the swings of the instrument. Later investigators recognized the electrode polarization which this method creates. It

is seen in the variations caused in response by the use of different types of electrodes. The problem has never been solved for this simple circuit, although a well-designed liquid electrode will minimize the effect. A sensitive galvanometer which is correspondingly unstable must be used. The deflections to large changes are of moderate size while small ones are not discovered.

Radecki (27) attempted to improve this technique by the use of capillary electrometer substituted for the galvanometer. Broxton and Muenzinger (2) have pointed out that this is also a closed-circuit, low resistance instrument and does not correct the difficulties attending polarization. They made an improvement by using a quadrant electrometer. This device leaves the electrodes on the skin in an open circuit at all times save when the instrument is being charged. It is shown that not the current which flows at a particular instant but the quantity of electricity which passes in a given direction determines the amount of polarization. Thus a galvanometer of great sensitivity would draw approximately 1×10^{-9} coulombs of electricity while their quadrant electrometer for a similar reading takes 2×10^{-14} coulombs. The amount of electrode polarization induced by so small a temporary current compares favorably with the best instruments recording exosomatic current.

This device, however, is also rendered unstable by its sensitivity. No workers with the endosomatic method have reported a device, equipped to record the measured fluctuations, which could conveniently be taken from the laboratory. In many researches such a record is necessary. The electrode problem is not entirely solved and most investigators find that pressure and moisture changes cause potential differences. However, it is interesting to note that Broxton and Muenzinger's electrometer method correlates well ($r = 0.86$ to 0.89 using 2 readers) with Hathaway's device (see below).

There are possibilities in a piece of apparatus which would employ vacuum tube amplification of these small endosomatic currents, providing they prove to be alternating or fluctuating in character. For successful operation the detector tube of any amplifier requires a negative bias potential on its grid. This current may be too large for some researches even in tubes especially designed to have a high input resistance.² Unless condensers or transformers are used, this current must flow through the electrodes at all times. This then constitutes an exosomatic circuit. But these same condensers or trans-

² The FP-54 Pilotron manufactured by the General Electric Company of Schenectady, N. Y., is of this sort.

formers block out any constant direct endosomatic currents. A solution of these difficulties would provide a piece of apparatus of value in endosomatic methods.

Exosomatic Measurement. Most investigators of these phenomena have used a method which introduces an external current into the body of the subject and have recorded fluctuations in his 'resistance'. Originally this method was preferred because it gave larger deflections of the galvanometer. It now maintains its popularity by permitting greater control over electrode polarization.

Direct current apparatus was used by all the early investigators, the usual circuit being a series containing 1 to 4 volts of battery potential, an observer, a switch, and a galvanometer. Electrode polarization was disregarded or compensation was attempted by the use of complicated contacts. Changes in the resistance of the contact made by electrodes were often included with tissue polarization in the records used. Generally the experimenter was content to interpret his results psychologically without worrying about what the gross physiological and apparatus causes might have been. The limitations of this circuit are rather obvious and Thouless (34) is its only recent exponent.³

Wechsler (35) brought together a number of improvements in his "psychogalvanograph". His instrument impressed the current from a dry cell delivering 1.5 volts across a Wheatstone bridge in which the subject formed the unknown arm. A fairly sensitive mirror and scale type of galvanometer was balanced at a zero-point on its scale by using the ratio arm of the bridge. Thus the subject's 'resistance'⁴ could be read directly from the bridge and any fluctuation showed itself in the deviation of the galvanometer from its zero balance.

His device included an arrangement for making a photographic record of these fluctuations as the experimenter watched them occur. Permanent graphic records of the response had only occasionally been made before because they usually involved the assistance of a second or third experimenter. This whole apparatus was contained in a portable box and was rugged enough to stand transportation. As designed at present the camera uses easily obtainable commercial roll film but has been modified in our laboratory (16) to employ the cheaper bromide sensitized paper. These features make the Wechsler a popular instrument for many researches.

³ Levine (23) uses a simple series circuit in a portable piece of apparatus designed to discover only body resistances and not electrodermal responses. He uses a very minute direct current and thus finds high resistances having no measurable changes during the short interval of measurement.

⁴ The term resistance will henceforth be used to include both true tissue resistance and polarization. It will be used similarly in discussing alternating current 'resistance', which should more correctly be termed impedance.

Dysinger and Ruckmick (9) improved this instrument by placing a second galvanometer within the camera box so that a blood pressure record might be made simultaneously with electrodermal variations. Further modifications made continuous records possible which are desirable when studying the responses during a long period of stimulation.

There are two undesirable features connected with the use of Wechsler's instrument. Nothing is done about electrode polarization and the galvanometer varies in sensitivity with different resistance ranges. A definite potential is applied to the bridge and the current through the subject varies both with changes in his own resistance and with the different bridge settings, to say nothing of changes in the electrodes. If the investigator is measuring only resistance between electrodes without reference to polarization of their contacts or heed of theories concerning tissue polarization, as was done formerly, the matter of the amount of current through the subject makes little difference so long as it is small. But comparison of records between subjects is still hazardous. The matter of electrode polarization may be regulated slightly by the use of liquid contacts (for example see Ruckmick and Patterson, 29). The problem is not solved, however, and at best the experimenter can honestly state only that this polarization is held as nearly constant as possible from one case to another.

The sensitivity of this apparatus varies so that a thousand ohm change in resistance from a level of 20,000 ohms results in a much greater deflection than a similar change at 60,000 ohms. Therefore to read resistance in ohms it is necessary to calibrate the instrument, as Thouless (34) points out. This becomes more difficult to do accurately when special electrodes which may have potential as well as resistance values are used. Certain workers (9, 16, 28, *e.g.*) have stressed this as a necessary technique for reliable comparative studies.

Darrow (6, 8) has brought the bridge type of measurement to its present state of perfection. He has solved the matter of polarization somewhat in the electrodes by having the resistances in 3 arms of the bridge fixed in value so that a balance results when a definite resistance (for example 100,000 ohms) is placed in the subject's arm. Additions or subtractions of 1,000 ohm steps from this balance provide a scale for measuring the subject's resistance. In addition, when the subject is in the circuit, sufficient resistance is kept in series with him to keep the galvanometer within its recording range. By having a large resistance in the circuit with the subject he is able

to use a potential (4.5 volts) large enough to keep a fairly constant current of about 0.04 milliamperes through the subject at all times. This potential is enough greater than the usual body potentials to eliminate their distorting influence on the recorded resistance. By keeping exosomatic current quite constant the apparatus measures resistance changes by recording potential variations in the output. Since the rate of polarization must depend upon the amount of current flowing through any solution, this factor is held at a fairly constant value, both in the electrodes and bodily tissues, in so far as it may be due to the exosomatic current itself.

The use of larger potentials and resistances in series with the subject makes the galvanometer equally sensitive to all ranges of the subject's resistance. Darrow has arranged his apparatus also so that photographic records can be made and transportation is possible. Continuous records are made in ohmage units and may be taken from 2 parts of the body at approximately the same time by means of a commutator arrangement.

Davis and Porter (3) have devised an apparatus for measuring electrodermal response which uses the amplifying action of vacuum tubes to increase the amount of output current from a potential impressed upon a subject to a point where it can be read on a milliammeter. They place the large plate resistance of a vacuum tube in series with the subject, and are able thus to avoid polarization effects in a manner somewhat analogous to Darrow's apparatus, while passing a current of whatever size they desire through the electrodes. The variations in potential output of this current from the body are impressed upon the grid of the first tube of an amplifier and increased to a point where they can produce a deflection in a milliammeter. The resistance level of the subject may be discovered at any time by a simple calculation. Muenzinger and Walz (25) have given useful data concerning tubes which may be used as current stabilizers in such an arrangement.

The chief value of this apparatus is that it somewhat avoids polarization problems by a constant current method while allowing the experimenter to select the current he wishes to use. Further, the deflections of the milliammeter are proportional to the dermal response. Its cost of construction is reasonable. Continuous permanent records of a photographic type are made with the aid of an oscillograph. A number of large "B" batteries are used and these make transportation inconvenient though not impossible. A radio 'power-pack' might possibly be substituted for them. The deflections of the milliammeter must be translated into ohms by calculation if the responses are to be reported in ohmage units.

Darrow (7) has suggested that his resistance box, which keeps a large resistance constantly in series with the subject, might be used in the input circuit of vacuum tube amplifiers as a means of standardizing the amplified record. This would enable the experimenter to know the resistance level of his observer at any time without the necessity of a calculation. If the resistors in the box used are wound so as to correct for inductance, it would be possible to apply a box of this sort to those devices which use an alternating exosomatic current (see below). An advantage would result both in the constancy of the impressed current and the ready discovery of the subject's resistance level.

Wenger and Griffith (36) have perfected⁵ a piece of apparatus in which the best features of the Davis and Porter circuit are retained, together with improvements of their own. They have employed the newer, more efficient types of vacuum tubes now available to construct an amplifier which may be used in several circuits.

For exosomatic measurement of the electrodermal response, a very constant current of whatever value desired is supplied to the electrodes of the subject from the plate circuit of a vacuum tube that not only provides a high series resistance, but has a self-biasing arrangement which automatically corrects other variations. The output of this current from the subject passes through the amplifier system, which has a considerable gain, and is read upon a milliammeter at the same time that it is photographed from the fluctuations of another milliammeter in series with the first. These instruments may be calibrated so that their fluctuations are easily changed into ohmage units.

The amplifier may be used in a second circuit in which no appreciable current flows through the subject and measurement is made of body potentials only. The system is now essentially a millivoltmeter. Only the bias current of the control grid of the input tube flows through the subject and this is found to have a value of about 2×10^{-8} amperes.

In a third arrangement a high impedance transformer coupling is used in the input circuit and measurement is made of the frequency of response in a manner similar to Godefroy's (see below). An exosomatic potential of 22.5 volts is applied in the subject's circuit, which also includes the resistance of the transformer's primary winding. The amount of current which flows in this circuit is controlled by means of a potentiometer. A stable zero-point for the recording meter is one of the chief advantages of the circuit.

Further, Wenger and Griffith have found that by using their amplifier in connection with a bridge arrangement, resistance

⁵ Devised at the University of Iowa in the Child Welfare Research Station. A description will be published shortly.

measurements to any degree of delicacy desired are possible. Convenient switching devices make for flexibility in changing this apparatus from one type of measurement to another. They have not included portability as one of their chief objectives, but the device is compact enough to be moved with little inconvenience.

Because of these various features this apparatus is probably the most convenient of the vacuum tube amplifiers for laboratories where several different types of measures must be made.

An interesting variation of the exosomatic current method was introduced by Godefroy (15) in 1922. Its use has been reported by a few workers since that time. He placed his subject in series with 10 volts of battery current and the primary of a one-to-one ratio transformer. The secondary of the transformer was connected directly to a galvanometer. Thus the (electro-tachogram) record produced showed variations from a straight line only when a change in the current flowing took place, *i.e.* change in resistance occurred. Polarization effects are, of course, present as in most direct current devices but since they occur slowly, they are not directly involved in the galvanometer swings and so do not appear in resistance changes. Care must be used in its operation, however, for about 2 milliamperes of current flow through the subject. If this is applied or reduced suddenly an electrical shock results. For certain research purposes the device seems worthy of further investigation. It is quite stable and requires no adjustment of the galvanometer to a zero-point after a reaction. So far it has been used only for discrete measurements.

Howell (18) has invented what he calls a psychogalvanometer that contains a circuit worthy of consideration. It is unique in allowing the experimenter to use either direct or alternating exosomatic current. In addition a few simple changes convert a portion of the device into an apparatus for administering a measured electric shock.

The supply current is drawn from a 60 ~ commercial outlet and is rectified by means of a vacuum tube so that a pulsating direct current is obtained. This is impressed on the subject through a megohm resistance in series with him. Thus a fairly constant current flows through the subject at all times as in the Darrow, Davis and Porter, and Wenger and Griffith circuits above. In parallel with the subject, connected directly across the electrodes, is a vacuum tube voltmeter, a common physical instrument that will detect changes in voltage while drawing a very minute operating current due to the high internal resistance of a vacuum tube. This reads in volts the

small fluctuations of current through the subject, due to his changes in resistance. The amount of direct current impressed upon the subject can be determined by the use of a sensitive galvanometer and regulated as the experimenter wishes. From these two readings the subject's resistance is calculated.

When the instrument is used with an alternating exosomatic current the rectifying tube is cut out and the potential of the commercial supply reduced by stepdown transformers. The galvanometric determination of the impressed current is impossible with a direct current instrument and it is therefore short-circuited. Thus the amount of current cannot be determined as accurately as in the case of the direct current operation. The voltmeter is operated in the same manner, however, and resistances are determined similarly.

The author reports two advantages of his apparatus in addition to those above mentioned. It is more sensitive than any other sort of direct current galvanometer yet reported and has a low construction cost. The one immediate disadvantage lies in the fact that the resistance of the subject must be calculated by means of Ohm's law. In alternating current usage this is not as accurate as in the case of direct current due to the difficulty of discovering the current factor of the law precisely. No device for recording responses save by observation of the voltmeter is reported, though a photographic apparatus could be devised if necessary. However, this is the only instrument known that attempts to keep an alternating current through the subject fairly constant.

The idea of using an alternating current instead of a direct one in the exosomatic method occurred to earlier investigators and Gildemeister (13) early used it in showing that what was measured by the method of Féré (direct exosomatic current) was not mere bodily resistance but resistance plus tissue polarization. It did not find general favor due to the difficulty of measuring either the intensity or potential of the output current.

It was hoped that an alternating exosomatic current would eliminate polarization effects and allow the experimenter to measure resistance changes in tissue only.

Landis (19) had an apparatus devised for using 60 ~ commercial lighting current to supply a bridge in which the subject formed the unknown arm. An alternating current galvanometer served as the recording instrument and the general operation was much the same as Wechsler's bridge. This was used by a number of investigators. However, he published an incorrect diagram of his circuit, and in a later article (21) did not encourage its use because it fails to obviate tissue polarization. Aside from this the apparatus is not amenable

to general research laboratories because of the cost and instability of sensitive alternating current galvanometers. Nothing that has been done further with such an arrangement is published in the literature.

Hathaway (17) devised a circuit for the use of alternating exosomatic current which has proved very popular. He felt, on the basis of some preliminary experiments, that a 60 ~ alternation was sufficient to avoid polarization effects. The correctness of this is still open to question, but certainly electrode polarization difficulties are reduced.

His apparatus derives current from a 60 ~ commercial supply. This current is run through stabilizing tubes and cut down by means of a transformer and a potentiometer to a value such that one-tenth of a milliamperere is impressed upon the skin of the subject at the start of an experiment. The output current is then fed through a push-pull input transformer into 2 vacuum tubes in parallel, where it is rectified and amplified so that changes in the subject's resistance may be read in the plate output current which activates a milliammeter. The value of this apparatus lies in its portability and in the convenience of the electrode used.

Ruckmick (30) has described a simple dry type of electrode which works well. Two inconvenient features are the numerous batteries needed in the circuit and the lack of a photographic apparatus for permanent recording. Hathaway makes provision for the substitution of a recording galvanometer to overcome this latter difficulty and Ruckmick and Grubbs have devised (at Iowa), but never published, a shadow recording camera for use with it. Smith (32) has reported a more accurate method of recording the deflections of the milliammeter hand than merely noting their amount. Further the response readings are given in terms of milliammeter deflections and these can be translated into ohmage units only with much difficulty. No attempt is made to keep the current through the subject constant after the starting amount has been determined.

Forbes (10) studied this instrument critically and found that the impressed current varied from 0.13 to 0.24 milliamperes as a subject's resistance decreased from 60,000 to 10,000 ohms. He also showed that the recording meter deflections were not proportional to the subject's actual resistance or the percentage changes in this resistance. Further, he pointed out that the resistance level of the subject is assumed to be constant by many experimenters, whereas really it is always changing. Hathaway agreed to these criticisms and said he intended the instrument to be used chiefly to show the frequency of responses without regard to their quantitative value. Forbes and Landis (12) have pointed out the misinterpretations which result from the uncritical usage of this apparatus.

Forbes (11) has also suggested some interesting apparatus in a study of alternating current responses. He used twin vacuum tube amplifiers with a cathode ray oscillograph and photographic recording. Responses were found at frequencies as high as 10,000 ~ or about double the value reported by Gildemeister as killing the response. Further, the alternating and direct current responses appeared concurrently. Unfortunately he has not published details concerning this apparatus which may prove of value in further theoretical research.⁶

Practically every investigator has used his own combination of apparatus especially with reference to the electrodes. The circuits described above are typical of the majority of devices, however, and with the clearer understanding of the problem of polarization which is possible today, it should not be difficult to devise a combination of circuit and electrodes to fulfil any particular demands of research.

For classroom demonstration a very simple device whose circuit can be understood by the enterprising student is desirable. In certain situations a record made by this apparatus is useful in providing data for group discussion or project work. Research in psychology generally uses the electrodermal response as an indicator of change in the autonomic nervous system. In these researches the recording device need be refined only to a degree that will enable it to show as small a change as is desired. In research on the physiological basis of the response, greater accuracy is demanded and here apparatus must be devised to fit particular problems.

A greater uniformity in apparatus for general psychological research would be highly desirable. Results depend largely upon the device used to obtain them and comparisons between experiments have often been difficult to make on that account. If future investigators state their results in ohmage units, where an exosomatic current is used, with the amount of that current used or the potential at which it was applied, and its frequency (if cyclic), together with a description of their apparatus and technique, more valid comparisons between data may be made than have been possible in the past.

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⁶ The author of this paper has constructed a constant, alternating, exosomatic current device which is useful for continuous measurement and records in standard units. A description will be published shortly.

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AN OUTLINE OF EXPERIMENTAL PSYCHOLOGY

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I would like to ask the reader's indulgence in the present outline of experimental psychology because it depends to such a large extent upon my systematic position in psychology.¹ The principal proposition on which the present organization of topics is based is that in considering any psychological function some account should be taken of the location, nature, and complexity of the bodily structures that are functioning. When the different levels of organic complexity are considered, the classification of subjects in experimental psychology becomes almost as natural as the classification of subjects in physiology.

After discussing a few preliminary subjects, our plan is to take up first those less complex processes which assist in the understanding of the more complex processes included in later portions of the outline, and we have tried to arrange the topics in such a way that most of them are just past due when they are reached in the classification. On passing from subject to subject through the outline one passes from the lower and less complicated levels to the higher and more complicated levels. The processes in the higher levels involve but are more than the sum of the processes in the lower levels, and the higher level activities cannot be reduced to some or all of the activities in the lower levels.

All of the activities in our outline are activities of the psychological organism, but some of the processes listed near the beginning are of considerable interest to physiologists, and most of those near the end are closely related to the social sciences. The experimental data included in the first divisions of the outline have been obtained from subhuman animals and from human subjects, and the results in the last sections have been obtained almost exclusively from human subjects.

¹ The author's general psychological position has recently been set forth in three papers on "Organic Psychology", I. The Scientific Nature of Psychology. *J. Phil.*, 1934, 31, 654-665; The Psychological Organism. *Psychol. Rev.*, 1934, 41, 356-367; and The Methods and Subject Matter of Psychology. *J. Gener. Psychol.*, 1934, 11, 187-193.

We have divided the subject matter of experimental psychology into 6 parts, and each part is further divided into divisions, subdivisions, sections, and subsections. A considerable amount of time has been spent in classifying the various subjects of "Learning, Retention, and Reproduction" (in Parts 4 and 5), and these topics are more finely divided than the rest.

Some subjects such as "Visual Sensations" (in Division 2-9) and "Wit and Humor" (in Division 6-6) are relatively easy to classify, but other topics such as "Attitude, Disposition, and Attention" (in 3-7) are not as clear and definite. The location of a few topics is not apparent from the outline, and we have added the names of some of these topics in parentheses to show where they belong. "Laterality of Function" has been classified under "Reflex Action" (in 3-2) rather than under "Inherited and Acquired Reactions" (in 3-1); and "Hallucinations" have been placed under "Waking and Sleeping Dreams in Man" (in 6-9) rather than under "Perception in Man" (in 5-2).

An attempt has been made to use the most appropriate and desirable names of the subjects in experimental psychology, but we have avoided a few commonly used words and expressions because of their undesirable connotations. Some of the words that have been avoided are adaptive, development, effector, growth, mechanism, mental, objective, and subjective. In later portions of the present paper we shall have occasion to comment on several divisions of the following outline.

AN OUTLINE OF EXPERIMENTAL PSYCHOLOGY

PART 1. INTRODUCTION

- 1-1. *The Scientific Nature of Psychology*
- 1-2. *The Psychological Organism*
- 1-3. *The Methods and Subject Matter of Psychology*

PART 2. BASIC PSYCHOLOGICAL ACTIVITIES

- 2-1. *Sensory Functions*
- 2-2. *General Visceral Sensations*
- 2-3. *Kinesthetic Sensations*
- 2-4. *Painful Sensations*
- 2-5. *Tactual and Thermal Sensations*
- 2-6. *Olfactory Sensations*
- 2-7. *Gustatory Sensations*
- 2-8. *Auditory Sensations*
- 2-9. *Visual Sensations*
- 2-10. *Lower Nervous Functions*
- 2-11. *Higher Nervous Functions*

2-12. *Muscular Functions*2-13. *Glandular Functions*

PART 3. GENERAL PSYCHOLOGICAL ACTIVITIES

3-1. *Inherited and Acquired Reactions*3-2. *Reflex Action and Organic Integration and Disintegration*
(Reaction Time, Laterality of Function)3-3. *Native Drives*3-4. *Affectivities: General*3-5. *Affectivities: Feelings* (Likes and Dislikes, Desires)3-6. *Affectivities: Emotions*3-7. *Attitude, Disposition, and Attention* (The Psychology of Errors)3-8. *Interest, Energy, Work, Fatigue, Rest, and Sleep* (Distractions)

PART 4. LEARNING, RETENTION, AND REPRODUCTION: LESS COMPLEX PROCESSES

4-1A. *The General Nature of Learning, Retention, and Reproduction*

B. Native and acquired

a. The genetic approach

C. Definitions of LR&R (Learning, retention, and reproduction)

D. Different degrees of LR&R

E. Different forms of LR&R and various degrees of complexity

a. Verbal, manual, affective, and glandular activities

1. Studies of humans and subhuman animals

F. The reflex circle

a. The rôle of the nervous system

G. Stimulus and response

a. Associationism

H. The total experimental situation

a. Gestalt psychology

I. The rôle of conscious activities

a. Learning when the subject is not conscious of the stimulus

b. Learning when the subject is not conscious of the response

J. Reminiscence and further consolidation after learning

K. Time as a measure of LR&R

L. General theories of LR&R

a. Physiological theories

4-2A. *General Conditions Which Influence LR&R in Man*

B. Age in man

C. Sex in man

D. Disease and health in man

E. Internal secretions in man

F. Drugs in man

a. Alcohol

b. Caffeine

c. Tobacco

G. Fatigue in man

H. Atmospheric conditions in man

I. Time of day, week, and year in man

J. Sleep in man

- K. Abnormal conditions in man
 - a. Organic deficiencies
 - 1. Sensory (Influence on imagery, perception, and thinking)
 - b. Organic disorders
- 4-3A. *General Activities Which Influence LR&R*
 - B. Native factors
 - a. Maturation
 - b. Native drives
 - 1. Subhuman animals
 - 2. Humans
 - C. Intelligence in man
 - a. Correlations between intelligence and LR&R
 - b. Correlations between abilities in LR&R
 - c. Relation between initial and final abilities
 - D. Set, attitude, interest, and incentive in man
 - a. The will to learn
 - b. The influence of recitation
 - c. Incidental memory and testimony
 - 1. Incidental memory
 - 2. Testimony and fidelity of report
 - E. Influence of stimuli acting during the LR&R periods
 - a. Internal stimuli
 - 1. Muscular activities
 - b. External stimuli
 - 1. Distractions
 - F. Affectivities
 - a. Pleasant and unpleasant feelings in man
 - b. The learning and retention of pleasant and unpleasant activities in man
 - 1. Experiments with restricted laboratory material and activities
 - 2. Studies of more lifelike situations and activities
 - c. The pleasure-pain theory of learning
 - 1. Subhuman animals
 - 2. Humans
 - G. Abnormal activities in man
 - a. Functional disorders
 - 1. Hysterical phenomena
 - Amnesia
 - b. Hypnotism
- 4-4A. *LR&R Activities Principally Involving a Single Stimulus and a Single Response*
 - B. The law of adaptation or fatigue
 - a. Tropisms
 - b. Sensations
 - c. Reflexes
 - d. Verbal activities
 - e. Manual activities

- f. Affectivities
- g. Glandular activities
- C. The alleged law of habit (or use)
- D. The alleged law of disuse
- E. Free association

4-5A. *LR&R Activities Principally Involving Two Stimuli and Two Responses*

- B. The conditioned response
 - a. General
 - 1. Physiological theories
 - b. Lower animal forms
 - c. Verbal activities
 - d. Manual activities
 - 1. Subhuman animals
 - 2. Humans
 - e. Affectivities
 - f. Glandular activities
 - 1. Subhuman animals
 - 2. Humans
 - g. Galvanic skin responses
 - h. Abnormal activities
- C. The law of contiguity
- D. Paired associates in man
 - a. Learning foreign vocabularies
- E. Recognition in man
 - a. Sensations and perceptions
 - b. Verbal activities
 - c. Affectivities
 - d. Abnormal activities
- F. Discrimination, judgment, and choice: selecting one of two responses
 - a. Subhuman animals
 - b. Humans
 - 1. Psychophysics and judgment
 - c. Comparison of subhuman animals with humans
- G. Controlled association in man
- H. The double-stimulation theory of learning

PART 5. LEARNING, RETENTION, AND REPRODUCTION: MORE COMPLEX PROCESSES

5-1A. *Imagery in Man*

- B. Synthesia in man
- C. Eidetic imagery in man

5-2A. *Perception in Man*

- B. The origin and nature of perception in man
- C. Meaning in man
- D. Illusions in man
- E. Perception of spatial relations in man
- F. Perception of temporal intervals in man
- G. Perception of movement in man

5-3A. *Language, Speech, and the Simpler Forms of Thinking in Man*

- B. The origin of the simpler language activities in man
 - a. Listening
 - b. Thinking
 - c. Speaking
 - d. Reading
 - e. Spelling
 - f. Writing
- C. The rôle of inner speech in the different kinds of LR&R in man
- D. Abnormalities of speech in man
 - a. Aphasia
 - b. Stuttering

5-4A. *LR&R Activities Involving Several Stimuli and Several Responses*

- B. Redintegration
- C. Cancellation, substitution, and card-sorting in man
 - a. Cancellation
 - b. Substitution
 - c. Card-sorting
- D. Simple problem solving: selecting one of several responses
 - a. Subhuman animals
 - 1. Trial and error behavior
 - Multiple choice
 - 2. The delayed reaction
 - b. Humans
 - 1. Trial and error behavior
 - Multiple choice
 - 2. The delayed reaction
 - c. Comparison of subhuman animals with humans
 - 1. In trial and error behavior
 - 2. In the delayed reaction

5-5A. *Less Complex Serial LR&R in Man*

- B. Less complex serial verbal activities in man
 - a. Theories of less complex serial verbal LR&R in man
 - 1. Physiological theories
 - b. Immediate memory span
 - c. Relation between efficiency of LR&R and length of the series
 - d. Influence of serial position
 - e. Remote association
 - 1. Remote forward association
 - 2. Backward association
 - 3. Mediate association
 - f. Retroactive inhibition
 - g. Whole *versus* part learning
 - h. Spaced *versus* unspaced repetition
 - i. The curves of retention and forgetting
- C. The association of ideas in man

5-6A. *Complex Serial LR&R*

B. Verbal activities involving logical material in man

C. Manual activities

a. Subhuman animals

1. In the maze

Backward association

2. Homing

b. Humans

1. The maze with human subjects

c. Comparison of subhuman animals with humans

1. In the maze

5-7A. *More Complicated LR&R in Man*

B. Skilled verbal activities in man

a. Learning a new language

b. Improvement in speed of reading

c. LR&R of material read

C. Skilled manual performances in man

a. Typewriting

b. Drawing

1. Mirror-drawing

c. Target hitting

d. Ball-tossing

e. Athletic performances

f. Playing musical instruments

D. Transfer of training and interference in man

a. Transfer of training

1. Cross education

b. Interference and inhibition

E. Habits in man

a. Eliminating undesirable habits

F. Abnormal activities in man

a. Methods of aiding reproduction

b. Early memories

c. Removing abnormal symptoms

d. Extraordinary LR&R

PART 6. PERSONALITY, ORGANIZATION, ADJUSTMENTS, AND MALADJUSTMENTS
IN MAN6-1A. *Complicated Problem Solving, Reasoning, and Creative Imagination in Man*

B. Insight

C. Formation of concepts

D. Reasoning

a. Arithmetic

E. Creative imagination

6-2. *Intelligence and the Correlation of Abilities in Man*6-3. *Personality Organization, Foresight, and Purpose in Man*6-4. *Forms of Social Stimulation in Man* (Suggestion)6-5. *Personality Adjustments and Maladjustments in Man*

- 6-6. *Wit and Humor in Man* (Laughter)
- 6-7. *Esthetic Activities in Man* (Recreation)
- 6-8. *Factors Leading to the Use of Drugs in Man*
- 6-9. *Waking and Sleeping Dreams in Man* (Hallucinations)
- 6-10. *Abnormal Activities and Psychological Hygiene in Man*

The most suitable introduction to experimental psychology seems to be a discussion of the scientific nature of psychology, and the relation between psychology and philosophy, biology, and the social sciences. Even if the facts of science are for the most part fairly concrete, students of science frequently acquire certain scientific prejudices in their high school and college courses. A discussion of such subjects as scientific levels, the relations between physiological and psychological processes, and the differences between humans and subhuman animals would seem to be fairly important in the general introduction.

The "Basic Psychological Activities" which we have included in Part 2 are concerned with the various activities involved in the reflex circle. In the complicated system of the reflex circle, the sensation is regarded by the present writer as the first activity which occurs in the central nervous system as a result of impulses passing to it over the afferent paths. Sensations may include some processes that are conscious, or they may include no processes that are conscious, but both conscious and unconscious sensations act as primary causal agencies in the organism. More than the usual amount of emphasis is placed on unconscious sensations in the present outline, and the lower nervous functions are regarded as both quantitatively and qualitatively different from the higher nervous functions.

The "General Psychological Activities" included in Part 3 involve many complicated structures or they have a broad and long continued influence on other activities. The study of "Inherited and Acquired Reactions" in 3-1 is of some aid in appreciating the origin and nature of all kinds of physiological and psychological processes. The subject which comes next in the outline is "Reflex Action and Organic Integration and Disintegration". The integrative and disintegrative reflex processes are largely unconscious, but some of them may be conscious and none of them possess the specificity of function that was formerly assumed. The general names of our "Native Drives" in 3-3 are nutrition, comfort, annoyance, fear, sex, ego, manipulation, and sleep; and each of these native drives involves both reflex and affective processes. Our native drives differ from what was once referred to as "instincts" in the

3 following respects: (1) the differential factors which originally produce our native drives are not entirely inherited, (2) the only assumptions made in regard to teleology are critical in nature, and (3) no sharp distinction has been made or attempted between native drives and affectivities. The last 2 divisions in Part 3, on "Attitude, Disposition, and Attention" and "Interest, Energy, Work, Fatigue, Rest, and Sleep", include several processes which are influenced by the affectivities and native drives; and these processes of attitude, attention, interest, work, rest, etc., have a fairly direct influence on learning, retention, and reproduction.

The less complex processes of "Learning, Retention, and Reproduction" are classified in Part 4, and the more complex processes are classified in Part 5.² Learning may be defined as the formation of connections in the central nervous system between stimuli and responses, and retention may be defined as the persistence of these connections for a period of time. Reproduction occurs when the stimuli are given and the responses, which were formerly connected with these stimuli by the process of learning, are produced again. Forgetting has already occurred when the stimuli are given and the responses, which were formerly connected with these stimuli by the process of learning, are not produced again. "LR&R" processes and states include both conscious and non-conscious activities, but we have emphasized the difference between verbal and non-verbal processes more than the difference between conscious and non-conscious processes. The present outline of LR&R includes memory, association, habit, the acquisition of skill, and a few other subjects which are not ordinarily classified under LR&R, such as imagery, perception, psychophysics, and language, speech, and the simpler forms of thinking in man.

The LR&R activities have been classified for the most part on the general principle of organic complexity, and the degree of complexity has been judged by the number and nature of the stimuli and responses that are involved. There are fewer stimuli and fewer responses in the less complex processes included in Divisions 4-4 and 4-5 than in the more complex processes included in Divisions 5-2, 5-3, 5-4, 5-5, 5-6, and 5-7; less bodily tissue is involved in the processes included in 4-4 and 4-5 than in the processes included in 5-2 to 5-7; and there is a general increase in organic complexity as one passes from 4-4 to 5-7. The less complex activities of LR&R precede and assist in the understanding of the more complex, but the more complex are more than the sum of the less complex, and the more complex cannot be reduced to the less complex.

² "LR&R" will hereinafter be used as an abbreviation for "Learning, Retention, and Reproduction".

It does not seem possible to separate the subject of Learning from the subject of Retention, or to separate either of these subjects from the subject of Reproduction. There always seems to be considerable repetition and some forcing when these unnatural separations are made or attempted. There is much less forcing and straining when all of the experimental data on the LR&R of the conditioned response are taken up together, when the subject of LR&R of paired associates is regarded as a unitary subject, when the LR&R of simple serial activities in man are considered as another natural subject, and when all of the topics under the LR&R of type-writing are grouped together. Although Retention can occur without Reproduction, and Retention can be for long or for short intervals of time, it is not desirable to attempt a separation between Learning, Retention, and Reproduction because whenever Reproduction is present, Learning and Retention must have occurred, and whenever Retention is present, Learning must have occurred. The present classification of LR&R according to the principle of levels of organic complexity seems to be a fairly natural one, and we hope that the outline of the subjects of LR&R will commend itself to the reader.

The subject of "The General Nature of Learning, Retention, and Reproduction" is classified in the first division of Part 4. We have assumed that there are different degrees of LR&R, and that it is desirable to obtain quantitative measures whenever possible. The different forms of LR&R have been grouped into the 4 classes, verbal, manual (in Watson's sense), affective, and glandular. It appears desirable to use the organic approach to the study of LR&R activities and to consider the total experimental situation, but the total situation which we have in mind is the total psychological organism and not the very limited conscious perceptual field of the Gestalt psychologists, and the conscious processes which we have in mind are organic causes as well as organic effects.

The "General Conditions Which Influence LR&R in Man" are classified in 4-2, and this division includes several general conditions such as age, sex, disease and health, internal secretions, drugs, fatigue, and sleep, which influence many different kinds of LR&R. These general conditions of LR&R are frequently taken into consideration in attempting to control the experimental situation.

The "General Activities Which Influence LR&R" in subhuman animals and in humans are classified in 4-3. This division is concerned with activities rather than with conditions as in the preceding division. "Maturation" and "Native drives" are classified under "Native factors", and "Intelligence in

man" is placed in a subdivision by itself. Under "Set, attitude, interest, and incentive in man" we have placed "The will to learn", "The influence of recitation", and "Incidental memory and testimony". The subdivision on the "Influence of stimuli acting during the LR&R periods" is a significant subject on which there is relatively little experimental data. The subdivision on "Affectivities" includes "The learning and retention of pleasant and unpleasant activities in man" and "The pleasure-pain theory of learning".

The law of adaptation is regarded as the most important subject in 4-4 on "LR&R Activities Principally Involving a Single Stimulus and a Single Response". The "law of habit" seems to be a more suitable name than the "law of use". We have not included the "law of frequency" anywhere in the outline because the concept of number does not seem to belong to the subject of LR&R any more than to other subjects in psychology and it does not seem to belong to psychology any more than to other scientific and non-scientific subjects. Free association (in 4-4E) is largely a matter of reproduction, and like other processes in the present division it involves principally a single stimulus and a single response.

The "LR&R Activities Principally Involving Two Stimuli and Two Responses" are classified in 4-5, and the most important subject in this division is the conditioned response. The law of contiguity has been placed in a separate subdivision, but this principle of association has sometimes been regarded as a relatively unimportant example of the conditioned response. Two stimuli and two responses are also involved in "Paired associates in man", "Recognition in man", "Discrimination, judgment, and choice: selecting one of two responses", and "Controlled association in man". We have classified "Psychophysics and judgment" under "Discrimination, judgment, and choice: selecting one of two responses" in Subsection 4-5Fb1.

The most general theory of learning for psychological processes principally involving 2 stimuli and 2 responses seems to be the double-stimulation theory of learning. According to this principle, learning of the two-stimulus-two-response degree of complexity tends to occur when 2 stimuli produce simultaneous effects in the central nervous system. In the two-stimulus-two-response situations, a connection tends to be formed between each stimulus (but principally between one stimulus) and a response not previously connected with the stimulus. Double-stimulation emphasizes the rôle of afferent nervous impulses in the central nervous system and the resulting conscious and unconscious sensations, and it directs atten-

tion to the primary causal factors in the reflex circle, that is, to the afferent nervous impulses.³

The double-stimulation principle is involved in the learning of "Imagery in Man" (5-1), "Perception in Man" (5-2), "Language, Speech, and the Simpler Forms of Thinking in Man" (5-3), and in all of the more complex processes in Part 5. But regardless of principles of learning, the processes of inner speech have an especially important influence on the more complex activities of LR&R in 5-4, 5-5, 5-6, and 5-7. In the LR&R of manual, affective, and glandular activities in man, the key to the psychological situation is frequently found in the processes of inner speech rather than in the manual, affective, and glandular processes themselves. Several experimenters have neglected the rôle of inner speech in their studies of LR&R of manual activities in man because they had a strong interest in behavioristic theory, but this neglect of inner speech is not even justified on behavioristic grounds. When a person learns to withdraw his hand from some object in response to a previously non-effective stimulus, the central process in the total bodily pattern is inner speech. We have placed "Verbal activities" before several other LR&R activities in the subdivision on "The conditioned response", and "Language, Speech, and the Simpler Forms of Thinking in Man" (5-3) have been placed before many of the more complex forms of LR&R. Some bodily processes are more important in LR&R than others, and inner speech is one of the more important processes.

Several of the "LR&R Activities Involving Several Stimuli and Several Responses" have been classified in Division 5-4. The principal difference between the conditioned response (4-5B) and redintegration (5-4B) is in the number of the stimuli and responses that are involved. Some of the topics such as "Trial and error behavior" which are included under "Simple problem solving: selecting one of several responses" (5-4D) are handicapped by the difficulty or impossibility of analyzing the bodily processes that are involved and of knowing what is taking place in the organism.

We have found the subjects of judgment, choice, problem solving, and reasoning somewhat difficult to classify, but have classified them in three places according to the general degree of complexity. The subject of "Discrimination, judgment, and choice: selecting one of two responses" has been placed in 4-5 because the activities principally involve 2 stimuli and 2 responses. "Simple problem solving: selecting one of several responses" has been placed in 5-4 because the activities involve several stimuli and several responses. "Complicated Problem Solving, Reasoning, and Creative Imagination in Man" are not regarded as forms of LR&R, and these subjects have been classified as the first division of Part 6 (on "Personality Organization, Adjustments and Maladjustments in Man").

³ A similar theory has previously been advanced by M. F. Meyer, Frequency, Duration and Recency *vs.* Double Stimulation. *Psychol. Rev.*, 1934, 41, 177-183.

Only serial activities have been included in Divisions 5-5 and 5-6. Division 5-5 includes "Less Complex Serial LR&R in Man", and Division 5-6 includes "Complex Serial LR&R" in both humans and subhuman animals. These serial activities are different from the processes included in earlier divisions of the outline, and one would not expect the same general principles of LR&R to apply when the organic processes differ so greatly from each other.

The LR&R of series of digits, letters, nonsense syllables, and words are classified in 5-5B, and these serial activities are less complex than others which have been placed later in the classification. Subdivision 5-5B includes "Immediate memory span", "Relation between efficiency of LR&R and length of the series", "Influence of serial position", "Remote association", "Retroactive inhibition", "Whole *versus* part learning", "Spaced *versus* unspaced repetition", and "The curves of retention and forgetting". A fairly successful analysis has been made of these less complex activities, and much information is available about what takes place in the organism. "The association of ideas in man" has been placed in a subdivision by itself, but this kind of association cannot be sharply separated from the less complex serial verbal activities in 5-5B.

The processes involved in "Complex Serial LR&R" (in 5-6) seem to be more complicated than is commonly assumed, and knowledge of what takes place in the organism at this degree of complexity is limited. The subjects of "Complex Serial LR&R" have been subdivided into "Verbal activities involving logical material in man" and "Manual activities". The principal topics included under "Manual activities" are "Subhuman animals in the maze" and "The maze with human subjects". The analysis of what takes place in the organism seems to have been more successful in the case of "The maze with human subjects" than in the case of "Subhuman animals in the maze". The analysis of what takes place in the animal's body when he is performing in mazes and puzzle boxes is handicapped by the extreme complexity of the organic processes and by the animal's inability to tell anything about his internal processes. The prospect of formulating general principles of LR&R seems to be better in the case of "The maze with human subjects" because the serial manual activities of humans are simpler and more accessible. The reasons for the somewhat greater modern interest in "Subhuman animals in the maze" are not entirely obvious.

Several forms of "More Complicated LR&R in Man" have been placed in 5-7, and the most central psychological activity in these processes of LR&R is inner speech. These complicated forms of LR&R are not well matched by equally complex processes in subhuman animals. Several of these complicated forms of LR&R in

man are important in themselves aside from whatever value they may have in the scientific task of establishing general principles.

The first subdivision of 5-7 on "Skilled verbal activities in man" includes "Learning a new language", "Improvement in speed of reading", and "LR&R of material read". Under "Skilled manual performances in man" we have included "Typewriting", "Drawing", "Athletic performances", and "Playing musical instruments". Verbal activities are involved in "Skilled manual performances in man", and they are also a factor in "Transfer of training and interference in man", "Habits in man", and "Abnormal activities in man".

It would seem from the above that the experimental data on LR&R can be classified on the basis of different levels of organic complexity with relatively little forcing and straining, and a few general conclusions seem justified if this classification is a fairly natural organization of the subject matter. The general principles of LR&R seem to be less general than is frequently supposed, and it appears that a larger number of general principles will be necessary if the organic psychological processes are to be adequately described. There is, it seems, no all-inclusive law of learning, although there are several general principles of LR&R which apply to single-stimulus-single-response situations, several other general principles which apply to two-stimulus-two-response situations, another set of principles which applies to several-stimulus-several-response situations, and still other sets of LR&R principles which apply to simple serial learning, complex serial learning, skilled manual performances, and so on. It also appears that there is no universal curve of forgetting, no all-inclusive relation between efficiency of LR&R and length of the series, no single law of whole *versus* part learning, and no rule about spaced *versus* unspaced repetitions which has no exceptions. There are principles which apply to each of a number of different levels of organic complexity, and it seems that future progress will have to be in the direction of analyzing more finely the processes involved in several organic levels. There are few, if any, general laws which apply to all of the different kinds of LR&R, but some of the general principles for the different levels of LR&R are much more general than others.

The last part of the present outline of experimental psychology is concerned with "Personality Organization, Adjustments, and Maladjustments in Man". The general subjects of "Complicated Problem Solving, Reasoning, and Creative Imagination in Man"

are placed before "Intelligence and the Correlation of Abilities in Man"; and the former division includes the formation of concepts and arithmetical reasoning. After these subjects, the plan of organization for the 3 following divisions is shown by the fact that with different kinds of personality organizations (6-3), the various forms of social stimulation (6-4) lead to personality adjustments and maladjustments (6-5). The subjects of "Wit and Humor in Man", "Esthetic Activities in Man", "Factors Leading to the Use of Drugs in Man", and "Waking and Sleeping Dreams in Man" are not well matched by similar activities in the subhuman animals. "Psychological Hygiene" (in 6-10) includes several topics which cannot be classified under "Mental Hygiene". The subjects in this last part of our outline (on "Personality Organization") have a broad and practical application to the social sciences and to the ordinary affairs of everyday life.

SPECIAL REVIEW

THORNDIKE'S FUNDAMENTALS OF LEARNING¹

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INTRODUCTION

This volume represents three years of experimental investigation by Dr. Thorndike assisted by the staff of the Division of Psychology of the Institute of Educational Research of Teachers College, Columbia University. Dr. Thorndike's chief collaborators were Dr. Ella Woodyard, Dr. Irving Lorge, Miss Mabel Wilcox, and Miss Parrish Little. The work was financed by a grant from the Carnegie Corporation.

The task which Dr. Thorndike set himself was a difficult one, that of determining the fundamental conditions under which "a situation which first evokes response A later evokes response B, different from A". Somewhat more specifically, the experiments center to a considerable extent around the attempt to obtain critical evidence as to the authenticity of Thorndike's two principles of learning enunciated in earlier works, the so-called "law of exercise" and the "law of effect". This seemingly simple situation developed into a huge research program involving over a hundred experiments which employed in the aggregate a small army of paid human subjects. The results are reported in 153 tables, some of them covering several pages each. In general, the magnitude of the experimental program arose from Thorndike's unusually persistent attempt to isolate and measure various supposedly basic conditions or "laws" of learning such as frequency, "belongingness", and effect. The task of isolation naturally proved to be extremely complex and difficult. It is this stubborn attempt at isolation of basic factors which makes the work of fundamental significance and gives a real appropriateness to the title of the book.

Upon the whole, the method of experimental approach was quite different from that usually employed in memory investigations. In

¹ Thorndike, E. L., *The Fundamentals of Learning*. New York: Bureau of Publications, Teachers College, Columbia University, 1932. Pp. xvii+638.

general the apparatus side of the experiments was extremely simple; none of the traditional memory machines was employed. These customary accompaniments of memory investigations were replaced for the most part by pieces of cardboard, pencils, and paper. Many of the experiments were so arranged that large groups of a hundred or more subjects could be taken through the learning simultaneously by methods somewhat analogous to those long familiar in group aptitude testing. In contrast with the simple mechanical side of these experiments, the variety and complexity of the psychological processes involved were very great.

THE INFLUENCE OF MERE REPETITION

The first 22 experiments reported concern, at bottom, the extremely fundamental question as to whether in the process of trial-and-error learning, the originally most frequently occurring of the several mutually exclusive reactions evoked by the stimulus situation will become more and more dominant with continued repetition quite apart from any reward or punishment or knowledge of success or failure. The typical experimental procedure of the initial experiments was either to estimate the lengths of numerous objects of systematically varied magnitude or to attempt to draw while blind-folded lines of systematically varied but specified lengths. These experiments agreed in general in showing that there was in truth a tendency for the reaction to become somewhat stereotyped, an extremely important finding; in so far the results supported the frequency hypothesis. It was found, however, that the reaction which was the most frequent in the end was nearly always one which was not the most frequent in the early stages of practice. This fact Thorndike considers as decisively in opposition to the hypothesis that mere frequency of repetition, of a situation has any selective influence in trial-and-error learning. Repetition of a connection, on the contrary, is shown later in the volume to exert always a real though small strengthening influence.

Because the preceding experiments involved a kind of threshold situation either in the stimulus or in the response, resort was had to a series of experiments in which both stimulus and response were clear-cut and specific. For example, a series of 150 English words was read, each word followed by a digit from 0 to 9. Following one reading of such pairs, these words were read over many times rather rapidly without the accompanying digit and the subjects were asked to write down a digit after each word. Naturally, the most

of these latter reactions were guesses and even for individual subjects were highly variable for any given stimulus word on the several occasions of its presentation. The question was whether the more commonly guessed digit reactions to any given stimulus word at the beginning became still more common on repetition, as one interpretation of the "law of use" would demand. It was concluded that the results show little or no evidence for any such tendency.

A variant of this latter type of experiment was to present nonsense syllables followed by digits in random order, each syllable always being followed by a digit at each occurrence but not always by the same one. Thus the syllable *mi* was followed 8 times by 7, 4 times by 6, 4 times by 8, 2 times by 3, and 2 times by 9. The question in this case concerns, once more, the principle of frequency. When the subject is tested, will the more frequent repetitions give reactions in excessive numbers at the expense of the less frequent; will, *e.g.* the syllable *mi* evoke a disproportionate number of reactions of 7 (which has had 8 repetitions), and comparatively few reactions of 5 and 9 (which have had only 2 repetitions each)? Thorndike concludes, once more, that the evidence indicates little or no tendency of this kind. This experiment, like many others reported throughout the volume, shows marked inconsistencies in the results obtained with different syllable and digit combinations. Presumably this results from the fact that the various syllables and digits were not systematically rotated so that each would occupy every possible rôle with one or another group of subjects in a particular experiment and thus neutralize the distortions of the final results from the unavoidable inequalities of the experimental materials.

BELONGINGNESS, IMPRESSIVENESS, POLARITY, AND MENTAL SYSTEMS

The next major series of experiments concerns in one way or another what Thorndike calls "belongingness". The present writer has had some difficulty in arriving at a clear understanding of this term as a general concept. As to its physiological basis, Thorndike remarks (p. 76) that "there are at present no hypotheses to disagree about". The experiments on the other hand, give numerous concrete examples of the meaning of the term. For example, the various words of a sentence belong together in a way that the terminal word of one sentence and the initial word of the following sentence do not. Again, pairs of numbers such as 218 97, 432 16, etc., copied in columns from dictation are supposed to yield belonging-

ness but "as near a minimum of association after effect" of the connection as is perhaps obtainable". Lastly, 2 words or nonsense syllables or numbers are said to belong together if the subject, because of instruction or otherwise, tries to associate the two in such a way that the presentation of the one will later recall the other. Several experiments, designed to show by simultaneous contrast the relative strength of learning where belonging does and does not exist and employing materials of the type just mentioned, yielded positive but comparatively weak values where there was presumably a very minimum of belonging. It is concluded that belongingness, whatever its nature turns out to be, is a factor of great importance in the learning process.

Passing from belongingness to impressiveness, it was found that in a word-number paired associate such as *kiss* 63, in which the first member is relatively impressive, the association with the number is much stronger than in cases where the initial member is presumably neutral, as in the case of the pair, *paste* 32. When the impressive word appears as the second member of the pair, the same facilitating tendency appears but it is much reduced. This finding is held to have significance for practical learning situations.

One experiment was conducted on what the author calls *polarity*. By this is meant the tendency for stimulus-response sequences to function more readily in the order practiced than in the opposite. The polarity of common foreign expressions such as *exeunt omnes* and of longish common words such as *calendar* was investigated. The experiment was made up in the form of a pencil-and-paper completion test; sometimes the first portion of the expression or word would be given and the subject asked to supply the lacking part, and sometimes this procedure would be reversed. It was found with both kinds of material that the score of successes was much higher when the subject attempted to supply the ends when the beginnings were given, than vice versa; this confirms in an ingenious new way the relationship first shown experimentally by Ebbinghaus in 1885, but since called in question by Cason.

The volume also contains results from experiments on the influence of repetitions of a series upon the omission of its intermediate terms, readiness, identifiability, and availability; and the influence of mental systems. Considerable space is devoted to the latter subject. The method of investigation was a pencil-and-paper adaptation of the well-known association experiment, particularly as developed by Kent and Rosanoff. Here "mental system" is contrasted with

simple habituation. For example, if the stimulus word *dear* evoked the response *sir*, this would be considered a case of simple habituation, but if the response were *fear*, some other principle than the mere frequency of sequence or use in the past must be operative. Such other determining principles are what are meant by mental systems. Several different varieties are pointed out, such as sensory systems, instinct systems, customary systems, and transcendental systems. In general these experiments, while not professing to be either very precise or very conclusive, do seem to indicate rather clearly that the great majority of associations obtained by the free association technique occur as the result of mental system rather than simple contiguous association. Thorndike does not conclude from this outcome that the most of our thinking is brought about by some mystical entity, but rather that "with better insight and fuller information we may expect all cases to be explained and that the general laws which, acting in very simple ways, cause *yours* and *yes* to call up *truly* and *sir* when acting in more complex and subtle ways, cause them to call up *mine* and *no*" (p. 371).

THE AFTER-EFFECTS OF REWARDS

The material concerning belongingness and impressiveness serves to make a transition from the first major problem of the investigation, which may be considered to be concerned in one way or another with the "law of frequency" as such, to the second major problem, which in one way or another concerns the "law of effect". Having shown that mere repetition of a situation has no influence, but leaves the relative strengths of the different connections unchanged, and that the repetition of a connection has an influence apparently too small to account for the amount of learning, Thorndike finds the matter of after-effects correspondingly more important. In this connection Thorndike remarks (p. 172), "How the after-effect of a connecting strengthens or weakens the corresponding connection may well be a matter for dispute, but that it often does so seems to me as sure as the fact of learning itself." Nearly 40 different experiments were devoted to this basic problem. One group of these experiments was essentially a repetition of those described above in connection with the matter of frequency, such as the repeated judging of the lengths of slips of paper, with the significant change that when the subject reacted correctly the reaction was followed by an announcement of *Right*, and when he reacted incorrectly the reaction was followed by

the announcement *Wrong*. The introduction of these after-effects always resulted in marked improvements in the scores.

In the long controversy which has centered around Thorndike's "law of effect" a number of objections have been raised to it based on the alternative hypothesis that while, as a matter of fact, learning is ordinarily associated with characteristic after-effects of trials, the learning itself is not due directly to the after-effect but indirectly through some other tendencies such as anticipation or rehearsal, which themselves may be directly dependent on the after-effects. In order to test these alternative hypotheses, Thorndike exercised enormous ingenuity in setting up a great number and variety of experiments which were intended to be crucial in that they would involve the principle of effect with opportunity for none of these other complications. In general it was sought to accomplish this by directing the subject to attempt a trial-and-error task such as guessing at the meaning of rare English words from a five-choice test form such as, 18, edacious, daring—tractable—sober—devouring—polite. The subject's reaction in each case was announced by the experimenter at once as *Right* or *Wrong*, with the intention of giving the subject no opportunity to make even a covert correction. But hidden within the experiment would be the fact that the correct reaction appeared zero times in the first choice at the left, 10 times in the second, 20 times in the third, 30 times in the fourth, and 40 times at the extreme right choice. The point of the experiment would be to see whether the after-effects of *Right* and *Wrong* distributed in this asymmetrical manner, *even though quite unnoticed by the subjects*, would produce an excess tendency on a test involving new material to similarly distribute the choices. After the experiment, the subjects were questioned as to whether they had noticed any tendency for reactions to be right in certain positions and wrong in others; the records of those who reported in the affirmative were naturally discarded. This general procedure was repeated with many variations and on many kinds of materials, such as foreign language vocabularies, cards with lines ostensibly for discrimination but which, at the same time, possessed other characteristics which were surreptitiously subjected to the systematic influence of the *Right* and *Wrong* "effects". Thorndike concludes after carefully canvassing the results from this vast amount of experimentation (p. 270):

"On the whole, the results of Experiments 49 to 68 . . . prove that a satisfying after-effect of a connection can and generally does strengthen that

connection directly, irrespective of repetitions or rehearsals or recalls of the connection and of images or other representations of the after-effects."

REWARD VERSUS PUNISHMENT

When Thorndike originally propounded his "law of effect", two effects were postulated, *satisfiers* and *annoyers*, the one supposedly serving to strengthen connections, and the other to weaken them. The numerous experiments concerned with the law of effect summarized above were directed primarily to the investigation of only one of these effects—that of satisfiers or rewards. It happens, however, that in most experiments on learning, both rewards and punishments of some sort are employed usually in close succession and in varying proportions. This fact naturally makes it difficult to tell how much of the joint result is due to each. The problem is of enormous importance, both theoretically and practically. Thorndike attacks it with the vigor and persistence which it merits. To this end he devotes 10 experiments.

A typical study involved the re-working of the experimental data obtained from one of the five-choice learning experiments previously performed. This employed a large number of such items as,

1. Abedul, ameer—birch—couch—carry—punch

The subject was required to guess one of the 5 English words as the equivalent of the initial Spanish word at the left, which reaction was at once announced by the experimenter as *Right* or *Wrong*, the former announcement being regarded as a reward, and the latter as a punishment.² In this way the list was gone over repeatedly so that many successive reactions (separated by varying but considerable intervals of time) were obtained from each subject to each Spanish word.

The results from 6 different experiments of the above nature are interpreted as showing an average of +52% strengthening of an original tendency by one reward of a *Right* announcement, and of -4% weakening (actually a slight strengthening) of a wrong re-

² It would be unsafe to urge in the absence of evidence that the announcement of *Wrong* has no element of punishment in the ordinary sense, though this may be regarded as a possibility. On the other hand there seems considerable probability that it may have a large element of frustration. General observation suggests that punishment gives rise to avoidance reactions, whereas frustration may give rise to nothing but experimental extinction, i.e. a mere inhibition of the tendency for the act to occur.

sponse by one punishment consisting of a *Wrong* announcement. Concerning the results of these experiments Thorndike says (p. 288):

"So far as our results go, then, all the learning in these six experiments can and apparently must be credited to the strengthening by the announcement of *Right*. There is not a particle of evidence that the announcement of *Wrong* weakened these connections enough to counterbalance the strength they gained from just occurring. The wrong connections wane in relative frequency, not because they weaken intrinsically, but because they are supplanted by the right connections."

This is, of course, a somewhat revolutionary conclusion. In judging the evidence which led Dr. Thorndike to give up a portion of his original "law of effect" in favor of the view just quoted, it is necessary to note the novel method which he employed in the interpretation of his results. In the "abedul" sample of the Spanish memory experiment given above, it is evident that according to chance, 20% pure guesses at the meaning of a Spanish word must fall on each one of the 5 possible choices. Suppose, now, that a subject guesses a certain English word and the guess is "rewarded". It is assumed that if the "reward" has any strengthening effect the next reaction to this same situation will show, in general, a frequency greater than 20% for the same reaction to occur. On the other hand, if a guessed reaction is followed by "punishment", it is assumed that if this has the usually assumed effect of weakening the original tendency, the next reaction to this situation should show a frequency *less* than 20% for the same reaction to occur. Thorndike accordingly assumes that the difference between the observed per cent frequency of "same" reactions and 20 should be an indication of the amount of strengthening due to one "reward" or of weakening due to one punishment, respectively.³

The propriety of subtracting the theoretical chance amount from the obtained results and attributing what remains to the influence of reward and punishment respectively is considered by Thorndike in connection with the example given just above which involved the Spanish vocabulary (Experiment 71). He says (p. 283):

³ It should be added that the above procedure was employed only in cases where the "punished", or "rewarded" reaction of the subject was a *different* word from the reaction made on the last preceding presentation of the stimulus situation in question. Thus in the "abedul" example given above, the first reaction might be *birch* and the second, *carry*, which is different. The question then will be whether the third reaction will be *carry* (same), or some other of the five possibilities.

"It is conceivable, though hardly possible, that, in spite of the nature of the task and of our precaution of never using a response which occurred in the first trial, we may, by using responses which occurred somewhere from the second to the fifth trial, be favoring tendencies which have a strength over .20. Such a selective error would be important. If, for example, the real strength of the tendencies was .30, all our measures of strengthening of the rights in Experiments 71, 72, and 73 should be reduced by .10, and all our measures of the strengthening of responses other than the one wrong in question should be increased by .10, since they would be differences from .70, not .80."

In such an event, of course, the mean outcome of the various experiments instead of being +52% for "rewards" and -4% for "punishments" would be +42% (52-10) for "rewards" and +6% (-4 + 10) for "punishments". If the deviation from chance were as much as 25% in the direction assumed, this would reduce the influence of reward to +27%, and increase that of punishment to +21%, thus presenting a very different picture.

A QUESTION OF METHOD

The reviewer has been very much impressed by the possibility of a constant error of the type discussed by Thorndike in the preceding quotation, and not entirely convinced by the reassuring evidence offered by the author (p. 283). It is well known from experimental studies of multiple-choice tests that as a general rule the natural choice frequency of the several possibilities in any five-choice test is not at all a chance one in the sense of the choices being equally distributed, as would be the 1's, 2's, 3's, 4's, 5's, and 6's on repeated throws of a die. On the contrary there will usually be one choice which will receive many more than the average, *i.e.* more than chance or 20%; a second choice which will be less but may still be well above average; a third which will be still less and may be something like the average; a fourth which will fall well below average, and a fifth with almost no choices at all. Now, in the case under consideration where the first and second choices of a given subject are different, it seems likely that the first would, in general, represent a subject's strongest natural tendency and the second, his next strongest natural tendency. But since even the second choice may quite possibly be well above the average in natural strength, there arises a robust presumption in favor of the possibility which the above quotation from Thorndike suggests, *i.e.* that there will be a natural tendency for the reaction following the reward to be repeated to a degree in excess of 20% because of factors other than the reward or punishment.

Such considerations as those just put forward, while giving little or no indication as to what the true values are, serve to throw serious doubt on the interpretation given by Thorndike to his experimental results. So far as the reviewer can see, the true values cannot be determined from the experiment as reported. It would seem, however, that significantly close approximations might be obtained by the addition of a simple control experiment set up substantially as follows. Groups of subjects similar to those originally employed might be run 3 times through the same material as was used in the original experiments, except that they should be "rewarded" and "punished" on the first trials but not on the second or third. By this procedure the third reactions of the control group (in cases where the second reaction was different from the first) should show within the limits of the sampling errors involved the per cent of "same" reaction that would have occurred as due to all factors known and unknown had the second reactions in the original experiment not been rewarded or punished.⁴ This value could then be subtracted from the frequencies of "same" reactions following "rewards" and "punishments" reported by Thorndike, in place of the theoretical 20% originally employed. The obtained differences might then be regarded as indications of the after-effects of the announcements of *Right* and *Wrong* respectively.

Fortunately there has been performed and reported by Stephens, since the publication of the volume here reviewed, an ingeniously planned experiment which, while by no means the same as the control experiment suggested above, may turn out to furnish a close approximation to the desired values.⁵ The Stephens study showed

⁴ A sagacious study recently published by Stephens, (Stephens, J. M., *The Influence of Punishment on Learning. J. Exper. Psychol.*, 1934, 17, 536-555) indicates that a mere stimulation, even though indicating neither failure nor success, may have a marked strengthening influence on a reaction tendency. If these indications prove to be valid they open up a new dimension in the study of reinforcing agencies. Among other things they would strongly suggest the inadequacy of the control mentioned above, because the control differs from the basic experiment in two respects: (1) it removes information concerning success or failure (which is its avowed purpose), and (2) it at the same time removes an obvious stimulation (which is tacitly assumed to be a neutral factor). In order to yield unambiguous results, a control experiment should differ from the main experiment in but a single factor (Mill, J. S., *A System of Logic*. New York: Longmans, Green, and Co., 1919. Book III, Chapter VIII).

⁵ Stephens, J. M., *Further Notes on Punishment and Reward. J. Genet. Psychol.*, 1934, 44, 464-472.

an actual tendency to the "same" response on the third trial, of 35% or 36% quite apart from reward or punishment, instead of the theoretical 20%. This experimental evidence greatly strengthens the *a priori* presumption cited above against the appropriateness of Thorndike's method of interpretation. Incidentally, Stephens finds both in this and in several other well-controlled experiments,⁶ one of them rather similar to that of Thorndike's cited above, that the "punishment" of being told *Wrong* after a reaction has a clear tendency to modify reactions in the expected direction, *i.e.* to weaken them. This tendency seems to be particularly marked where the "punished" reaction is originally relatively strong as contrasted with the originally much weaker reaction tendencies employed by Thorndike.⁷

THE DEFINITION OF "SATISFYINGNESS"

An important later section of the volume is devoted to the consideration of "adverse evidence and arguments". In the main this is concerned with various criticisms and attacks on the "law of effect" during the twenty-odd years since its original enunciation. This principle is definitely not a portion of a systematic psychological theory derived by a logical process from other and more basic principles in the sense that a theorem of geometry is a portion of a logical system derived by a deductive process based on a set of original assumptions and definitions. On the contrary, it purports merely to state one of the major basic conditions under which learning, as a matter of fact, occurs. On the surface this alleged law appears to be essentially the result of an inductive process, a fairly

⁶ Stephens, J. M., The Influence of Punishment on Learning. *J. Exper. Psychol.*, 1934, 17, 536-555.

⁷ Following the presentation of his own experimental results on reward and punishment, Thorndike subjects to analysis the original data of several of the more important published investigations concerned with the same subject. Moreover, since the publication of the book he and his associates have published a number of important studies bearing on the nature of the effects of rewards and punishments, notably one based on 64 chickens (Reward and Punishment in Animal Learning. *Comp. Psychol. Monog.*, 1932, 8, No. 39. Pp. 65), and two reports by Lorge and Thorndike in the *Journal of Experimental Psychology*, June, 1933, and June, 1934. These studies have an important evidential bearing on the problem here under discussion, but the scope of the present paper precludes a review of them. It is clear, however, that there is a serious need for a careful critical paper which will survey the increasingly large number of significant studies in this field, many of them stimulated by the vigorous attack on the problem as reported by Thorndike in the present work.

direct statement of the results of a large number of experimental and non-experimental observations. Thorndike states his law and its accompanying definition as follows (p. 176):

"When a modifiable connection between a situation and a response is made and is accompanied or followed by a satisfying state of affairs, that connection's strength is increased. . . .

"By a satisfying state of affairs is meant roughly one which the animal does nothing to avoid, often doing such things as attain and preserve it."

The results from the experiments concerned with the "law of effect" appear so obvious to Thorndike that he occasionally seems a trifle mystified that any informed person should fail to accept it as a plain matter of fact. A careful examination of the formulation just quoted may somewhat clarify the mystery. Despite its seeming definiteness, the formula, together with Thorndike's use of it, permits of several interpretations. Let us see what some of these possible interpretations are and how they arise.

In the first place, there are involved the following major variables: (1) An original situation which evokes a response; (2) a satisfying state of affairs; (3) a state of affairs which the organism will do things to attain or preserve; (4) a strengthening of the original tendency listed as (1). From these variables and the general context it is possible to formulate a number of more or less distinct statements:

I. States of affairs which Dr. Thorndike feels as satisfying are, as a matter of fact, always states of affairs which *he* will strive to attain, and vice versa.

II. States of affairs which Dr. Thorndike feels as satisfying are, as a matter of fact, always states of affairs which not only he *but all other men and all other vertebrates* will strive to attain, and vice versa.

III. States of affairs which Dr. Thorndike feels as satisfying to a certain degree (as measured on a *subjective* scale ranging from zero to infinity) are states of affairs which both he and all other vertebrates will strive to the same degree (as measured on an *objective* scale ranging from zero to infinity) to attain, and vice versa.

IV. In addition to the perfect association or correlation involved in the three preceding statements of relationship, there is the possibility that the two variables are correlated only "roughly", *i.e.* only to the extent of $r = +.76$, say.

If (Cases I, II, and III) the correlation between the two variables

considered above is perfect, it makes no difference which of the two phenomena is used as the basis for investigating the supposed strengthening effects of the several "states of affairs". But the moment this correlation departs appreciably from $r=+1.00$, the question must arise as to which of the two is the real or active variable, and which one is the sign. This gives rise to the following alternative possibilities.

V. The satisfyingness of a state of affairs is the active or essential strengthening factor in the law of effect, but the behavior of doing such things as attain said states of affairs is employed as a "rough" but more convenient sign of the presence of, or the degree of, the condition of satisfyingness.

VI. The potentiality of doing such things as attain the state of affairs is the active or essential strengthening factor in the law of effect, but the feeling of satisfyingness is employed as a "rough" but more convenient sign or indicator of the presence of, or the degree of, the potentiality of doing such things as attain the state of affairs.

Which (if any) of the above possibilities did Thorndike mean? Sometimes he writes as if he favored the subjective as primary. For example, he uses such expressions as "to feel better" and to "feel notable satisfaction" (p. 79), in contexts which might easily be understood as indicating a "state of affairs" which should be expected to "strengthen a connection". While such lapses may be nothing more than an easy informality of writing, they are about as subjective as could well be imagined and have probably deterred some from accepting the "law of effect". On other occasions, Thorndike seems not only to insist stoutly that the "doing of such things, etc." is the primary factor, but tacitly to uphold the American prejudice in favor of behavioral objectivity to which he has contributed so much. For example, he remarks with emphasis in one place, *apropos* of this general situation (p. 461):

"But our criterion is objective, being that a satisfying state of affairs is the one which the animal does nothing to avoid, often doing such things as attain or preserve it."

But is the "criterion" the active or essential factor, or is it a mere convenient indicator of the active factor? And which of the two variables in the above formulation is the "criterion"? The reviewer is unable to express an opinion with any considerable confidence.

But if objectively observable behavior is the real criterion, why complicate the situation with the entanglements of the subjective feelings of "satisfyingness" at all? If the two are really equivalent why not substitute the former for the latter in the formulation of the law, and thus avoid the ambiguity? In that event the law would read substantially as follows:

When a modifiable connection between a situation and a response is made and is accompanied or followed by a state of affairs which the organism does more or less to attain or preserve, that connection's strength is increased.

It is conceivable that the course of the experimental investigation of this hypothesis would have been rather different if originally formulated, and consistently thought of, in this manner. In the first place, if an unprejudiced investigator were provided with this formula and directed to go into the laboratory to test it experimentally, he would recognize at once that a thorough job would involve the making of the two following independent measurements for any given "state of affairs" involving the organism:

(1) The extent to which the organism will strive to bring it about;

(2) The extent to which a connection will be strengthened by having the "state of affairs" occur.

In order to insure a fair sampling of "states of affairs", a good many different ones would need to be subjected to this paired measurement. After rejecting those states of affairs toward which the organism displayed no tendency to "do such things as attain or preserve", the Pearsonian coefficient of correlation could be computed for the remainder. After correction for relevant attenuation, the statement of the "law" seems to demand that the resulting value should be $r = +1.00$, though possibly Thorndike's use of the qualifying term *roughly* might imply the expectation of a correlational value appreciably below perfection.

It is evident that a positive outcome of the above experimental investigation would merely establish a relationship but would not give any indication as to the nature of the relationship. Moreover, it would be a relationship between "learning" on the one hand and "motivation" on the other. In other words, as it stands the "law of effect" is a double thing; it is just as much a law of motivation as it is a law of learning. If this is true it ought to be possible to state the substance of the "law of effect" purely as a principle of learning without the complication of a second and possibly irrelevant

hypothesis regarding a relationship between learning and motivation. Without incumbering the formula with many clumsy but ultimately necessary qualifications, and in the general style of Thorndike, the "law of effect" would then appear somewhat as follows:

When a modifiable connection between a situation and a response is made and is accompanied or followed by certain states of affairs, that connection's strength is increased.

It is this which is the fundamental and indubitable core of certainty inherent in Thorndike's "law of effect"; it is this, apparently, which he means by the words quoted on page 811 above. The reviewer has for a number of years been using the term *conditioning* in substantially this sense.⁸

WHICH IS PRIMARY, STRIVING OR REINFORCEMENT?

As we have seen, there is implicit in Thorndike's formulation not only a law of learning but, in addition, an hypothesis correlating learning with motivation. From such evidence as is available it can hardly be doubted that these factors are positively correlated in practice, though as yet no systematic effort appears to have been made to determine the extent of the correlation. This serves to raise the fundamental question as to which of the two variables is primary. Does the motivation (striving) produce the learning (strengthening), or does the learning produce the motivation, or does some third and still more basic process produce both? Thorndike seems to imply that the striving is primary, though he does not specifically say this. The reviewer, on the other hand, rather inclines to the view that the "conditioning" or strengthening is primary. By this is meant that striving can probably be derived as a theorem from the principles of conditioning as basic assumptions.

While space is not available here to present a rigorous deduction of such a theorem, it will be possible to suggest the general nature of the argument. The deduction would probably set out from the

⁸ Thorndike would not agree to this use of the term conditioning (see p. 401 ff.), inclining to reserve its use for what he calls "associative shifts". The reviewer, on the other hand, is inclined to believe that "associative shifting" will prove but a special case of the "law of effect" as stated above. Skinner has explicitly subsumed both cases under the same term (Skinner, B. F., *On the Rate of Formation of a Conditioned Reflex*. *J. Gener. Psychol.*, 1932, 7, 274-286).

assumption that there are originally certain primary reinforcing "states of affairs". According to the hypothesis these "states of affairs" (if positive) will tend to strengthen any stimulus-response combination which chances to occur in close temporal proximity. Now, *some* of these stimulus-response combinations will have no causal relationship to the "state of affairs", *i.e.* if they occur they will not be followed by the "state of affairs"; if they are ever brought into operation the fact that they will not be followed by the reinforcing "state of affairs" will cause them to suffer experimental extinction (internal inhibition)⁹ and they will therefore soon disappear. But in real life situations (as distinguished from the usual artificial laboratory situations) acts which precede the occurrence of any particular "state of affairs" on any particular occasion are likely to be genuine causes of such "states of affairs". This is to say that unless over-ridden by opposing factors, such causal action sequences will always bring about the "state of affairs" in question. It follows that whenever such causal stimulus-response combinations occur, the fact that they will tend strongly to be followed by the reinforcing "state of affairs" will cause them to be strengthened more and more. But acts which invariably lead to certain "states of affairs" unless over-ridden by opposing circumstances, constitute "doing such things as attain", *i.e.* striving for such "states of affairs". *Thus the organism through the mere process of conditioning will come to strive for states of affairs which are positively reinforcing.*¹⁰

On this assumption, states of affairs which organisms will strive to attain are reinforcing agents, not because they will evoke striving, but they evoke striving now because at some time in the past they were potent reinforcing agents, thereby joining stimuli and responses (or the habit-family equivalents¹¹ of responses) which constitute the striving. Naturally, present effects of past reinforcing power should be excellent evidence of further powers of the same kind.

IN CONCLUSION

This work of Professor Thorndike and his loyal corps of associates is truly monumental. It is fundamental, as its title promises.

⁹ Pavlov, I. P., *Conditioned Reflexes*. New York: Oxford University Press, 1927. Pp. 48 ff.

¹⁰ It will be observed that this theoretical development conforms to the principle of parsimony in that it reduces striving to a secondary or derived principle, thereby reducing the number of primary assumptions by one.

¹¹ Hull, C. L., *The Concept of the Habit-Family Hierarchy and Maze Learning*. *Psychol. Rev.*, 1934, 41, Part I, 33-52; Part II, 134-152.

It displays an immense amount of combined industry and experimental ingenuity. If not always wholly convincing to biased critics, it is certain to prove extremely stimulating through its bold challenge to current views, modes of thought, and methods of experimentation. Already a considerable literature, largely experimental, has been evoked by it. No serious student can safely shirk the very considerable labor of mastering it in detail.

BOOK REVIEWS

ROBINSON, E. S., *Law and the Lawyers*. New York: The Macmillan Company, 1935. Pp. xi+348.

This is a book by a psychologist suggesting ways and means of improving the usefulness of the law and lawyers to human welfare. However, it spends little time or attention upon the psychological studies of testimony, tests of mental abilities, and mental pathology. Its concern is chiefly with the more fundamental psychology of the thought and action of legal scholars, judges, and lawyers. Moreover, its author uses psychology as a sample of science more than as a restricted body of facts and principles.

Its plea is for a study of the institutions and activities of the law in the spirit and by the methods of the natural sciences. Observation and experimentation with prediction and control as the tests of truth should, he argues, supplement, and often replace, analyses tested by consistency, and so-called logic! He is confident that the opposing doctrines—that law as a science is normative and that law as an application of science is an application of ethics—are probably often in error and always inadequate, and that, if they were not, it still would be worth while to try studying law as we study engineering, medicine, education, and business, and to study all of these as we study atoms, bacteria, habits, and wants. Law in particular deserves a naturalistic treatment because it is such an important factor in human or social engineering. It would be foolish to labor at improvements in human relations in labor, trade, politics, charity, and crime to the neglect of the law, which plays so dignified and decisive a rôle in evaluating and controlling human behavior of all sorts. He is thus an ally of Cook, Frank, Hutchins, Llewellyn, Michael, Slesinger and other legal “realists” or “naturalists”.

I shall not summarize his discussions of the “Right and Wrong” rule, Intent, The Reasonable and Prudent Man, Personification, Rationalization, Conflicts, Judicial Deliberation, Natural Law, Legal Fictions, etc. It will be more instructive and much more entertaining if, instead, I quote a sampling of his trenchant comments and conclusions. “The social philosophy that is actually expressed in public policy is that of the man of law. . . . The man of law and

the man of science differ in their sense of responsibility to fact. . . . According to a certain kind of so-called logic there seems to be an impossibility about the holding of contradictory beliefs, but psychologically there is nothing more easily understood. . . . Three voices dominate the intellectual life of man: authority, internal consistency, and direct experience. . . . The man best fitted to guide us in our reform of legal institutions is he who has given frankest consideration to what that institution is as a natural phenomenon. It does not seem likely that we shall find surer basis for moral judgment in a jurisprudence which stands aside from psychological thinking and seeks its values within the grammar of its own speech. . . . [In a scientific jurisprudence] *stare decisis* would stand simply for a general timidity upon the part of judges against changing their way of thinking. The *ratio decidendi* of a case would be simply the best possible psychological account of why the court came to its decision. . . . An intellectual comfort secured through abstinence from available facts is not to be tolerated. . . . The theory that the common law is the expression of the personality of the Anglo-American people does nothing but set up in the background of those people the kind of a personality that would just naturally make this kind of common law. . . . When politicians say that they are worried about 'liberty' or 'bureaucracy', it is almost certain that they are worried about something else. . . . Whenever a critical problem of wide social significance falls within the domain of the judge, he feels a certain obligation to assure the legislators and administrators that he is not treading on their toes. . . . Any decision we do not like is apt to appear legalistic to us and broad-minded to our opponents. . . . The courts sometimes evoke the most mystifying concepts simply in order to do the sensible thing and to do it quickly and neatly. . . . [The scientific attitude] will help to center the minds of public-spirited lawyers upon the business of social control and to divert them from the almost useless occupation of castigating sinners. . . . If law should ever be considered naturalistically by the professors and the books, the art of compromise could be faced more squarely. Suppressing and repressive devices could be studied, not as logically inevitable outcomes of conflict, but as drastic mechanisms to be used in social control with something of that thoughtfulness and caution with which a well-trained physician prescribes the soporific drug or the surgical extirpation."

The discussions of the legal mind and the methods and criteria which direct its action are illustrated, though rather scantily, by

cases and decisions, familiar perhaps to lawyers but fascinating to psychologists.

Professor Robinson presents facts and refrains from making particular prophecies or recommendations, though he hints that clinics may replace criminal prosecutions and that declaratory judgments to prevent disputes and litigation about business matters may replace ordinary conflicts before a court. He also seems to favor replacing legal fictions by frank extensions and amendments of the law and of the meanings of words and phrases.

In due time the "scientific" (or "naturalistic" or "realistic") thinkers about law should be ready with such particular prophecies and recommendations, since, by their own doctrines, these will be the crucial tests of value. And here some surprises may await us. Although *homo sapiens* is certainly seldom prudent and logical, and seems to psychologists, social workers, and the like to need something like a clinic and school in criminal cases and something like a trustee or guardian in civil cases, treating him *as if he were responsible and logical* (with certain opportunistic allowances) may work better! Although science is certainly better than custom on the average, the customary legal treatment of the persons involved in civil suits may work better than would a set of rules devised and enforced by a committee of the most scientific economists, sociologists and psychologists now available! Although a certain improvement in human life seems to require only a change in the law and lawyers, it may really require a change in the general population!

The sciences of man have special difficulties in application because they do concern men. They are the most promising hope for a confused and doubting world, but they should not promise too much too soon. And they must be forever on their guard against neglecting important factors.

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BENTLEY, M., and COWDRY, E. V. (Editors). *The Problem of Mental Disorder*. New York: McGraw-Hill Book Company, 1934. Pp. x+388.

Acting as a committee for the National Research Council, Drs. Bentley and Cowdry have gathered papers from 25 fields which are directly or indirectly concerned with the problem of mental disorder. The first 5 papers are by psychiatrists, each of whom represents a

different school of thought. The remaining 20 range from various minute branches of neurology to social anthropology and education. The task undertaken has been gigantic: to present a picture of current beliefs in psychiatry and an analysis of the possible contributions to psychiatry of every subsidiary field which is in any way relevant. To the credit of both editors and authors it must be said that the task has been completed in splendid form. Defense and derogation of isms have been relegated to their deserved oblivion, and if the book seems dull to those who thrive on polemic it will delight and thrill the student anxious to discover a broad and solid basis for his experimental or systematic study of mental disorder.

Aside from the omission of G. V. Hamilton's objective psychopathology, a serious error in the reviewer's opinion, the 5 psychiatric viewpoints seem representative of current practice and theory: clinical, medical, neurological, psychobiological, and psychoanalytical. The first, presented by Macfie Campbell, describes psychiatry as dealing with the total personality at each of several levels of description, the chemical, physiological, psychological, and sociological. The patient is considered and treated as a unit which may have been affected at any or all of these levels. This position seems to differ little in any major way from that adopted by Adolf Meyer in his psychobiology, except that the latter emphasizes more strongly the "integrated" organism and stresses the danger of isolating, as the psychologist allegedly does, the various psychological functions (memory, thinking, etc.). Wechsler, as a neurologist, follows this approach closely, recognizing clearly the effect of social and emotional conflicts in the generation of disorders. He expresses a rather perfunctory belief, however, that the neurologist will eventually discover a specific condition of the nervous system to account for each form of disorder. Myerson, adopting the medical approach, is less lenient toward social and psychological causes. Each disorder to him is a specific disease with a unique pathological basis; "the paradigm of general paresis" is the foundation stone for his faith. Kubie, as a psychoanalyst, concedes the importance of hereditary and organic agents in etiology but insists that a proper consideration of psychogenesis is essential for treating the neuroses and many so-called functional psychoses.

In two particulars do these various writers diverge from one another. First, they emphasize different aspects of the disorders and recommend diverse techniques for their study; and second, they have different faiths as to essential etiology. The latter difference

derives from the former and both probably result from fundamental differences in training and temperament. Campbell, Meyer, and Wechsler recognize the rôle of organic factors and habit formation as coöperative causes and seem to realize the necessity of dealing with habits in terms of habits. Myerson, however, would apparently find the physiological mechanisms of habits and treat bad habit formations through the nervous system, while the psychoanalyst would limit himself to treatment through habit reformation. Convictions concerning etiology follow logically the interests expressed. Myerson puts an almost religious faith in organic pathology and Wechsler insists that the nervous system must be further examined; neither, it is clear, is much interested in the mild neuroses. On the other hand Kubie admits that psychoanalysis has limited itself to the non-organic disorders; but, he says: "It is only an unresolved emotional bias which makes either party belittle the efforts of the other or contend that all variables will be found by his own particular approach."

The supporting sciences represented fall into a few general classifications: 8 papers are concerned with various aspects of neurology, 2 with hereditary factors, 4 with extra-neural influences (endocrinology, virus diseases, nutrition and pharmacology), 3 with psychological influences, and 3 with cultural and educational variables. The aim of these papers has been to suggest broadly what has been done in each field and what of relevance to psychiatry each can offer for future research projects. The fertility of several of these fields, as brought out by the papers, will doubtless astound many who have come to look with pardonable suspicion on new ventures and hypotheses in this realm.

In spite of the expressed hopes of Wechsler and Myerson, the neurological approach as described by the 8 contributors seems to hold but little immediate promise of providing a working basis for the etiological problem. Only 4 of the 8 seem really to have touched on the topic of mental disorder in other than a cursory manner. Stanley Cobb on cerebral anatomy and physiology, Bishop on the electrophysiology of the brain, G. H. Parker on the evolution of the nervous system, and Herrick on neural integration give interesting accounts of the relations between neurology and psychology as sciences, but they do little more than point out that the nervous system is the organ which is deranged in the mental disorders and that this fact must be kept in mind by research workers in that field. The remaining papers, Jacobson on relaxation and electrical meas-

urements of neural and muscular impulses, Cowdry on neurocytology, Page on brain chemistry and metabolism, and Penfield on neuropathology, are more concrete in their suggestions. Jacobson urges an examination of nerve and muscle impulses in the psychoses, in the form of correlative studies, and presents an abundance of evidence to demonstrate the value of such an approach. Both Cowdry and Page see the almost immediate necessity of examining the brain from a chemical standpoint. Dr. Page describes in detail a number of chemical conditions which lead to objectively measurable changes in gross behavior, and his suggestions for specific experimental problems indicate an unusually clear understanding of psychiatric problems; the reader cannot but feel encouraged by his bold and stimulating hypotheses concerning the chemistry of behavior. Dr. Penfield is bold, too, but he cuts one or two Gordian knots with such ease, *e.g.* the topographical location of the seat of consciousness, that his conclusions must be accepted with reservation. He says "the elaboration of an anatomy and a physiology of conscious processes is a prerequisite to the creation of a true psychopathology". With such a prerequisite it is to be doubted whether we shall ever have a "true psychopathology".

The 2 chapters on inheritance will prove a grave disappointment to those who have pinned their hopes of an eventual explanation of mental disorder on the mysteriously omnipotent gene. Jennings warns against too facile explanations in terms of heredity and describes in painful detail the difficulties which will necessarily attend any experimental program designed to study the factor of inheritance. His chapter is a model of description but presents little other than a brief résumé of current inheritance theory in its broader outlines. Dr. Walter Freeman describes the failures of many attempts to discern a relation between physical constitution and psychological attributes. In spite of such failures, he says, it must be noted that certain relationships or constellations do exist and careful analyses of these will clear the way "for more penetrating researches on the chemical aspects of the problem of mental disease".

The effects of endocrine imbalance (Hoskins) and nutritional conditions (Minot) on psychological processes are supposedly great but largely uncharted as yet. In both of these papers, as well as in those on inheritance and brain chemistry, it is emphasized that the nervous system does not operate solely without reference to its intra-organismic environment. By examination of some of these

environmental conditions, light may be thrown on the origin of what seem at present to be perverse activities of the brain itself. One of the great difficulties in abnormal psychology has been the lack of opportunity to produce artificially the conditions which are found in such a tangled state in the disordered person. To solve this problem Drs. Robert and Ada Yerkes offer the non-human primates. Their paper abounds with methodological suggestions and general research projects which might profitably be undertaken in a primate laboratory; it will undoubtedly serve as an invaluable stimulus to workers in this as well as the general psychological fields.

The sociological contributions to research methods are touched on lightly in 2 papers, one by the Shermans and one (Cultural Anthropology) by Kroeber. The former presents recent findings on the differences between cultural and racial groups with reference to delusion content in grandiose and persecutory delusions. The tentative interpretations are stimulating indeed. Kroeber shows in detail the relation between symptoms of disorder in western culture and normal magical and religious activities in primitive cultures; in this connection he raises the question of how normality may be differentiated from abnormality.

Of perhaps most direct interest to psychologists will be the contributions of Professor Bentley and Dr. Leta Stetter Hollingworth. Professor Bentley, in a scholarly presentation, provides a complete systematic position from which both normal and abnormal psychological processes may be observed. He distinguishes the "triple-man" (mind-body-soul), the "double-man" (mind-body), and the single man. The single man is structurally single but functionally plural; this plurality is composed of "physiological doing" and "psychological doing". According to this view the total behavior of an organism can be described in terms of physical and chemical interactions (physiological functions) on the one hand and interactions of the organism with its own products and issues (psychological functions) on the other. This conception will not be new to those familiar with Professor Bentley's previous systematic discussions, but a careful analysis of his application of it to problems of disorder will be highly profitable. He sees the factor of "government" of the psychological functions as the key-note to abnormality and pleads for the study of various forms of government (initiation of action) in the child and the social man. Adoption of this attitude will eliminate the necessity of hypothesizing the various forms of gov-

ernment described by Freud (instinct, libido, id, super-ego, *et al.*) and will make unconscious processes merely "residues" of previous functioning. The experimental work of Kraepelin is cited as an example of the proper sort of laboratory approach.

While one cannot help sympathizing with Professor Bentley's wish to remove useless concepts and disembodied spirits, it must be noted that he has simply relabeled various systematic concepts of behavior-initiation as "forms of government of psychological functions"; this relabelling will probably not satisfy all psychologists. Likewise, elimination of the problem of consciousness does not seem altogether wise. There is a widely accepted empirical observation that two processes, apparently similar except for the degree of accompanying consciousness, may affect subsequent behavior differently. This need not be interpreted to mean that consciousness *per se* is efficacious in initiating behavior but that the presence or absence of consciousness may be a useful *criterion of the difference between two acts* which otherwise appear the same except for their effect on subsequent behavior. However, except to those who have a strong bias in favor of some other systematic position, Professor Bentley's paper will seem a sound and thorough presentation of the systematic questions which the psychologist who wishes to study mental disorder must face.

Dr. Hollingworth's paper is presented under the rubric of education, but to many will appear as definitely psychological as Professor Bentley's contribution and, perhaps, considerably more practical in aiding the initiation of research. Her chief interest is in determining the ways in which the child learns to be disordered in his behavior, frankly limiting herself to a description of the principles of learning and habituation in social and emotional behavior which produce the adult derangements. Whereas Bentley wishes to analyse behavior into the operation of component psychological functions and to describe the condition of these functions in insanity, Hollingworth would consider behavior as a changing thing which can be observed to change in the direction of normalcy or abnormalcy. Her contribution is an analysis of the factors which lead to these changes and the winnowing out of those which are important in the development of disorder as we define it. Such processes as regression and too-long-retained habits of childhood are shown to be of paramount importance. Dr. Hollingworth's viewpoint and her suggestions easily rank with those of the Yerkes in being the most fruitful con-

tributions offered to experimental psychologists in the book, although at first glance they may appear more relevant to the clinic or classroom than to the laboratory.

Too much cannot be said for the editorial synthesis of the diverse materials presented in this volume. Each of the two main sections (psychiatry, supporting sciences) is excellently summarized and abstracted; the reader who has not time to read through the whole can discover the papers deserving of special attention with ease, and in the final "Summary and Reflections" he can be informed, without great effort on his part, of the most important conclusions to be drawn from the book as a whole.

In spite of the sophistication and scholarliness of the papers presented, one confusion pervades them and deserves emphatic comment. Although Professor Bentley has done his best to clarify the issue, the term *mental disorder* has been seriously misunderstood by many contributors. The neurologists and some of the psychiatrists insist that all mental disorder must be describable in terms of brain states even though the specific states have not as yet been discovered. This possibly implies somewhat more than the writers have realized or intended. There is little necessity, of course, for Wechsler's insistence that what is called "psychological" is mediated by the nervous system; no one would question it in the slightest today. But it is clear enough, as Bentley has said, that many "peculiarities" of behavior result from the interaction of psychological functions with the residues of the patient's own functions or those of his associates or forebears. While these are mediated by the nervous system they are not necessarily the result of structural pathology in the sense of gross lesions.

If *mental disorder* is to mean only those conditions which arise as the result of tumorous, degenerative, or other organic pathological invasions or changes of the nervous system, then the neurologist and pathologist is confessing sheer ignorance of well-established facts by attempting to discuss certain neuroses and personality malformations under the rubric of mental disorder. On the other hand, if *mental disorder* is simply a descriptive term applied to all behavior which involves the activity of the psychological functions in an extreme and unbalanced way, the question of etiology cannot be put aside with the perfunctory and (usually) vituperative statement that all causes will be found in the nervous system.

There seems little question but that, although the nervous system

is involved in every act of the organism, many acts can more easily be described and (in derangement) treated in terms of a higher and more complex level of description than that of neuro-anatomy or physiology. For example, the learning of nonsense syllables is necessarily at present described in terms of psychological import and the probabilities are that, since this behavior is complex and involves many characteristics and parts of the nervous system, it will always be so described. The same applies to certain mental disorders. The psychological functions are disordered and the patient is spoken of as *psychologically* abnormal. Inasmuch as the disorder arose from the interaction of habits, thoughts, wishes or other psychological processes, it can be most economically described and modified in terms of and by manipulation of those same psychological processes. When a drug can be found, or a brain operation envisaged, which will change in any significant fashion such habits as, *e.g.* over-dependence on parents or resort to phantasy in lieu of direct need-eliminations, then will the psychologist be content to admit that all mental disorders (a descriptive term) are of organic pathological importance (*not* etiology) and should be described in physiological terms rather than psychological ones.

The essence of the difficulty is terminological; many writers assume that *disease* implies organic etiology. When the term *mental disease* is used, therefore, they demand an etiological description in terms of organic pathology. At the same time they are bound by classical usage to include phobias, obsessions, etc. as legitimate parts of the psychiatrist's subject matter; hence the demand for organic etiology in disorders of psychological functions. It must be remembered that there are many forms of psychological activity which, from a therapeutic standpoint, may be considered as *disorders* but which are not in any sense *diseases*. In the medical realm a physician may discover that his patient's low metabolic rate is the result of an underdeveloped and hypo-active thyroid gland; he does not speak of the gland as being diseased. It is simply disordered. Likewise the psychological functions and their government may be disordered without being diseased. If the psychiatrist is to treat the great majority of *mental disorders* successfully, he must not confuse that descriptive term with his medically significant term *disease*.

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THORNDIKE, EDWARD L., *Adult Interests*. New York: The Macmillan Company, 1935. Pp. ix+265.

For more than 30 years, the contributions of Thorndike in the fields of psychology and education have attracted wide attention. During this period he has published at least one sizable volume per year, not to mention numerous articles in magazines, professional journals, bulletins, and reports of commissions and committees prepared under his direction. When therefore a new volume by Thorndike appears, it at once commends itself.

We may look upon the book under consideration as a sequel to the volume on *Adult Learning* published in 1928. It is intended primarily for workers in the rapidly growing field of special or part-time adult education but should be of great help to all college teachers who, after all, work with students who may rightly be called young adults. Writing for this special group and for a rather definite purpose, the author has aimed at clearness and has achieved this result to a remarkable degree. As he himself states in the preface,

"It has seemed best to secure clearness and brevity even though this entails dogmatism, apparent neglect of psychological doctrines which are held widely, and possibly over-confidence in results obtained by us but not yet confirmed by others or generally accepted."

While the admitted purpose of the volume is as stated above it nevertheless is of great significance to the psychologist: first, because it throws much light upon the general problem of interest; second, because it pioneers in the comprehensive study of adult interests; and third, because of the new and original techniques and devices reported as having been used or suggested for future use.

Nowhere in the entire volume is a definition of *interest* offered. This is probably due to the fact that such a definition would entail arguing the psychological problems of interest with all the attendant differences of viewpoint which have been developed by various psychologists. Considering the purpose for which the volume was intended, it was no doubt wise to use the term *interest* to mean certain things without going through lengthy explanations and justifying arguments. It goes without saying that by reading through but very few pages, one becomes clearly aware of the fact that interest in the old sense, that is, as a faculty which can be aroused, or stimulated, or attached, or which is under the complete control of the individual so that it can be kept alive or active by him in any connection he desires to have it function, is not the usage employed or

implied. In fact, the theme of the volume is not *adult interest* but rather *adult interests*.

Interest is then used primarily to signify that, because of the very nature of the human being, certain situations or happenings are more potent in initiating certain types of behavior than others, or that conditions can be created under which certain situations become more potent than before in initiating and sustaining responses. What such conditions are in relation to the learning activities of adults is then a major consideration of this volume. In consequence of such an interpretation, adult interests can be determined with greater or less accuracy through experimentation and carefully controlled observations.

Through the first 6 chapters, general principles of psychological as well as educational significance relative to interests in general and interests of adults in particular are developed. These deal with changes in interests with age (Chapter II), the control of interests and especially adult interests (Chapters III and IV), learning what is uninteresting (Chapter V), and developing interest in elements of subjects, activities, or situations (Chapter VI). The conclusions reached in these discussions are stated without extensive presentation of experimental data in the body of the discussion. These data can be found, in part, in the seven appendices (pp. 163-252) and in a companion work entitled *The Psychology of Wants, Interests and Attitudes*.¹ In this volume the author presents in greater detail some of the studies supporting conclusions and viewpoints of the book under consideration.

Space permits only the very brief citation of some of the outstanding conclusions at which the author arrives. These will be presented with but little comment.

Referring to changes in interests with age (Chapter II), Thorndike summarizes as follows (p. 8):

"If these results may be taken at or near their face value, the decrease in the general mass or volume of interest is so slight that plans for adult education may disregard it."

Again, on page 12, we read:

"The decrease in total volume of interest from the twenties to the fifties is thus slight, and is restricted largely to physical activities. The interests most needed to support adult learning show no decrease."

¹ Thorndike, Edward L., *The Psychology of Wants, Interests and Attitudes*. New York: D. Appleton-Century Company, 1935. Pp. x+301.

The conclusion here arrived at is in harmony with the author's findings relative to the gradual and limited decline of learning ability between the ages of 20 and 45. (See *Adult Learning*). Significant as these findings are to the educator, they are equally meaningful to the psychologist who is interested in the changes in man's mental make-up due to age.

Again, considering the control of adult interests (Chapter III), Thorndike outlines certain principles which would appear to be applicable to people of all ages. He concludes, for example, (p. 30) that

"... Desires, emotions, attitudes and interests seem to be modified by their after-effects in the same way that traits of intellect and skill are. Mental connections are strengthened by repetition and reward, i.e., by occurring and by satisfying the person in whom they occur, as truly when the response is one of feeling or attitude as when it is one of thought or action."

Considering repetition alone as a factor of increasing interest and reducing dislike, the author concludes (p. 38) that

"Repetition is a two-edged sword".

"... the fact that repetition has no mystical intrinsic powers over likes and dislikes, but operates by changing the ability, its consequences or one's expectations from it, implies that it may change attitudes unfavorably."

On the other hand, assuming an attitude of interest even when the interest is not there, seems to have some value. To quote again (p. 41),

"On the whole a person may be hopeful that honest efforts to act as if he had an interest in a certain sort of learning will foster that interest to some extent, and may be confident that, even if they do not increase interest, they will facilitate learning."

Probably even more significant is the principle (p. 45) that, "Except for a few eccentric individuals, persons will on the whole like most those activities in which they do best. The average degree of correlation will be substantial."

While Thorndike does not advocate a pedagogy which would not make use of intrinsic interests, he does announce definitely and with much finality that learning without intrinsic interest can and does take place. While he states (p. 47) that "learning without interest of some sort does not occur to any appreciable degree", he continues (p. 52) with the conclusion that "the notion that the mind will not learn what is alien to its fundamental purposes is attractive and plausible but definitely false".

This conclusion is based on his observations in 9 years of experimental work on the learning of adults. The practical deduction which he draws from the entire discussion of learning things which are not intrinsically interesting is briefly stated to the effect (p. 53) that "if a stretch of dull learning can be learned as it is in ten hours, it will usually not be profitable to spend five hours in making it so interesting that it can be learned in seven".

Following the first 6 chapters, in which numerous general principles and conclusions of great significance are stated, the above being merely a few instances, Thorndike follows with a chapter on "Differences Between Old and Young" in which the facts seem to indicate that while differences do exist, they are, on the whole, not so striking and large as is popularly believed. This discussion is followed by certain generalizations concerning inventories of likes and dislikes. The author here impresses his readers and especially teachers of adults with the complex nature of that behavior in man which is usually called interest. To quote only briefly,

"The interest in leading an adult to take a certain course of study may similarly be much more than just the interest in the learning represented by that course. Vocational advancement, increased earnings, opportunities for sociable, or at least gregarious activity, prestige values, and the restoration, maintenance or increase of one's good opinion of oneself—these and other aims indicate that interests in power, status, and approval are at work."

Here again the conclusion parallels closely the descriptions of the complexity of learning which appear in various chapters throughout the volume *Human Learning* by the same author. The reader will no doubt recall that in this study, Thorndike completely destroys the notion that connectionist psychology must of necessity give a mechanical explanation of learning, describing it as a process of establishing a simple and additive array of one-to-one connections. As in learning, so also in the case of interests, especially the acquired or learned interests, the entire individual is really engaged. After all, learning processes and learning interests cannot be sharply differentiated.

In the ninth chapter, Thorndike takes up the discussion of individual differences in adults as to interest or interests. The facts presented indicate that in intensity and probably in number of interests, adults distribute themselves continuously and unimodally as on a scale measuring any capacity such as learning ability. For practical purposes it will therefore not be feasible to classify learners in distinct groups such as low, average, and high interest groups.

The last 3 chapters of this volume deal with timely analyses of educational problems connected with the now very-much-alive enterprises of adult education in which the government is investing heavily. While a review for a psychological journal need not give a detailed account of this part of the discussion, workers in the field of adult education and administrators of these projects would do well to give considerable attention to it. These chapters deal respectively with the problems of the distribution of adult education, the curriculum of part-time education, and methods of teaching adults. The administrators of adult education have no more fundamental problems than these to consider, and nowhere can they find so straightforward and effective a discussion of them.

The general effect resulting from reading this volume is that of becoming impressed with the characteristic ingenuity and originality with which research devices and experimental situations have been created by the author, as well as with the far-reaching significance of the results obtained. To the student of Thorndike an easily recognizable underlying system of psychology is revealed in each chapter. The style of writing is typically 'Thorndikian', inclusive of the striking and apt expressions and illustrations which frequently reveal the ideas with such unexpected force and clearness as to arouse one's risibilities. In this volume as in many others which have come from him, Thorndike is again pioneering venturesomely.

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MÜLLER-FREIENFELS, RICHARD, *The Evolution of Modern Psychology*. (Trans. by W. Béran Wolfe.) New Haven: Yale University Press, 1935. Pp. xiii+513.

This history features the semi-philosophical rather than the experimental trends, and the temper of American psychology will give the book a somewhat scholastic atmosphere. The task of psychology is herein conceived to be an account of the "structure of the soul", and wherever possible an endeavor is made to point out the "totalitarian" aspect of the point of view under discussion. This word "totalitarian" is used with a fervor that is as a matter of fact reminiscent of a few modern psychologists, and it gets the student about as close to scientific understanding as did Emerson's "Essays". Under it the actual empirical advances of psychology since 1880 are smothered in paragraphs of repetitious and sometimes unintelligible verbiage.

In the introduction is briefly sketched the developmental "strategy" of psychology, from primitive animism up to the scientific approach. The new method began with the study of the minds of psychological specialists but "was soon extended to include women, children, babies, Eskimos, Polynesians, Bushmen, and other exotic objects". The conclusion has as a sub-title, "Is There a Soul?" In the volume the author evidences a wide range of scholarship, with limitations that are excusable enough, even in one who has the courage to undertake to write a history of psychology.

There are six main "parts" to the rest of the book. Part I considers psychology as the study of consciousness, a readable and impartial account of the men and doctrines. Elementarism, associationism, the Gestalt, eidetic and non-sensory schools are described in very general terms, as are also the critical objections to the whole analytic program. Minor errors are numerous. Did Galton really find that "scholars can form no pictorial images"? There is no psychologist named Dullanbach. There was no "Würzburger" school. It was not merely non-visual elements that the Würzburg school tried to introduce. Titchener did *not* identify clearness and intensity. The use of "mental experience" in a way which excludes "feeling and will" is at least not common. "The Psychologies of 1925" was not edited by W. Murchison. "Ebbinghaus, Cattell, and other American psychologists" is misleading to those who need to be told about them, and so on. These are small errors, but they are many, and a history ought to be correct.

The section is instructively and fairly organized, with perhaps over-emphasis on Dilthey, Bergson, and other philosophers, and it has the author's customary slowness in getting under way.

Part II deals with "Physiopsychology and Psychophysiology". The book abounds in these unclear distinctions and verbal combinations. Later on there are also psychosociology, sociopsychology, and biopsychosociology. This section reviews the controversies over cerebral localization and over physical constitutions. These developments are also seen as leading toward a "totalitarianism", whatever that may be. The reader is wisely warned that much of the alleged physiology perpetrated by psychologists is only an attempt "to illustrate mental functions by means of figures of speech". The main point of this section is that anatomical and physiological theory moved in a direction parallel to that taken by the consciousness psychology. "These paths, in both instances, led away from atomizing mechanisms toward a totalitarian point of view. . . . The problem of a

'soul' organically governing consciousness and physical life—now came into its own." It is, however, freely, and fortunately, admitted that this outcome is "at most a nebulous halo from which a clear light may develop".

Part III considers "Action and Conduct". It is a rambling section, skipping from Bain and Darwin to James, Dewey, Münsterberg, Watson, McDougall, Woodworth, Thorndike, Klages, Kretschmer, Piéron, and including reflexology, instinct and psychovitalism. Here above all are found opportunities to point to "totality", or, as the author says, "the problem of totality obtruded itself". This obtrusion led to "a school of research which states explicitly that psychology with a soul is the goal of its studies".

Part IV is given to this "school". It has a motley membership—the testing psychologists, the phenomenologists, the personalists, the "understanding" psychologists, and the characterologists. Students of individual differences and advocates of psychometrics will not all agree that they have been explicitly endeavoring to portray the "structure of the soul". As a matter of fact the citations and interpretations of this part of the section will appear decidedly out of focus to American readers. It was not Kirkpatrick, Kelly and Norsworthy who "preëminently" advanced the intelligence tests. Nor did Childs feature heavily in the work of the Stanford Revision. Nor is it true that "the first compendious psychology of the entire course of human life" was essayed by Charlotte Bühler. An account of theoretical psychology that features Calkins and neglects Washburn is excusable only from the hand of a foreign scholar.

From racial psychology "we select only what is significant for the problem of soul structure". This note runs through the book, for to the author that is the problem of modern psychology (and of any other psychology). Culture psychology, characterology, with the other ventures described in this section, led, it is maintained, to the conviction that "Mental life does not belong to nature. . . . The soul is a whole that exists before its parts", although "one must admit that this totalitarian soul is not yet known with complete clarity". The author blithely fails to wrestle with the problem of how a non-natural object could be known, even with partial clarity.

The fact of the soul's supernatural existence is however further demonstrated in Section V on "The Unconscious". Here are given sympathetic accounts of hypnotism, Freud, Adler, and Jung. The

personal peculiarities and eccentricities of these developments are fairly evaluated.

In Part VI the totalitarian story culminates in "The Psychology of Superindividual Psychic Life". Social psychology, psychosociology, sociopsychology, and biopsychosociology, and the psychology of cultures and of history are here surveyed, distinguished, compared, and briefly illustrated.

An appendix presents "with some hesitation", and in finer print, accounts of the interests and activities of the societies for psychical research (parapsychology)—mind reading, telepathy, clairvoyance, prophecy, telekinesis, levitation, and materialization. The topics are presented with charity and left as open questions.

A chronological bibliography is given for each section; usually only the author's name and the title of book or article is given, with no further guide to location.

Psychology is a fairly interesting subject, and it is curious that most books on its development seem dull and verbose to American students. In the present case the special quality of the book is determined by its neglect of objective accomplishments in favor of what are called the "theoretical" issues; by a certain ecstasy over the word "totality"; by insistence on the use of "consciousness" as the name for an array of original items rather than for a certain type of "report"; and by the conviction that the task of psychology is the delineation of a supernatural construct rather than the increasingly adequate description of certain natural events.

H. L. HOLLINGWORTH.

Columbia University.

Studies in the History of Ideas, III. (Edited by the Department of Philosophy of Columbia University.) New York: Columbia University Press, 1935. Pp. 511.

This volume, which contains 13 individual studies of varying length, type, and value and which lacks both a general introduction and an integrating point of view, can scarcely be reviewed as a whole. Attention rather must be directed toward the separate contributions. The subject matter conforms to the pattern of philosophic problems, historically conceived, rather than to the history of ideas cast against the background of social history. One would not be able to deduce any predominant *motif* in contemporary thought from the contents, although methodology appears to receive more

attention than anything else. Several studies give precedence to the technique of approach over actual subject matter, yet in the more distinguished contributions method and content are brilliantly fused.

McKeon in the longest essay in the volume, "Renaissance and Method in Philosophy", has attempted to discover "what the Renaissance believed . . . by translating a historical sequence of ideas . . . into the philosophic debate that is implicit in the relations of those ideas". The particular "sequence" that he has chosen is the three-cornered debate between Abailard, Erasmus, and Luther, respectively the dialectician, the grammarian, and the rhetorician, concerning the effect of pagan philosophy on Christian doctrine. If he has not always achieved clarity, he has given us a suggestive study which is important less for its content than for its exposition of method in intellectual history. It is not enough, he repeatedly emphasizes, to know a man's ideas: we must also know what other men thought of those ideas, for what they thought has been perhaps more influential than what the man himself meant (assuming that can be known). Moreover, we must know how men of entirely different outlook interpreted his ideas, since the interpretations themselves vary as much from one another as any one interpretation differs from the original set of ideas.

No less successfully Hook casts his essay, "Hegel and Marx", in the form of a debate between his two subjects, thus illustrating the technique which McKeon has expounded, and seeks to answer the question, "How did there develop from what was ostensibly the most conservative system of philosophy in the Western-European tradition, the revolutionary ideology of the greatest mass movement since Christianity?" He is concerned with the process by which Marx was able to discard Hegel's doctrines and yet adopt his method. Marx opposed Hegel's "teleological spiritual idealism" as an obstacle to his own revolutionary concepts since he saw that Hegel's whole social philosophy was of a piece with his religious philosophy and embodied a defense of the bourgeois *status quo*. For Hegel, history was the autobiography of God, the march of the human spirit toward freedom, but Marx saw history as the creation of men and reeking with tragedy and stupidity. What Marx did was to hold the mirror up to Hegel. To say that Stalin and the Sage of Palo Alto have drunk at the same spring may sound almost blasphemous, yet both are Hegelians, one on the ground of dialectic, the other on that of doctrine.

Cast in a somewhat different mold are two substantial essays on Descartes. The first, by Balz, reveals its point of view in the title, "Cartesian Doctrine and the Animal Soul: An Incident in the Formation of the Modern Philosophical Tradition", and develops the thesis that the controversy whether animals were or were not machines illustrates much seventeenth and eighteenth century thought. Choose either a flea with an immortal soul or man as a machine, said Voltaire, and thus summed up the dilemma of those who appreciated that if an animal is no more than a machine, then in all probability man too is an automaton. Balz concludes that as an incident in the history of ideas, the question is not closed, even though the debate as it was carried on two centuries ago now appears "somewhat quaint and unreal", for, translated into current terminology, the problem would lose its "historical remoteness".

In "The Rôle of Descartes in Seventeenth Century England", Lamprecht maintains that Descartes "deeply influenced every English thinker of consequence (and many of less importance) between 1640 and 1700". Newton and Locke ended Descartes' influence and unconsciously produced a misunderstanding of his ideas, because what they disregarded in Descartes came to be considered as invalid. The rôle of Descartes was by no means uniform during the century, running from acclamation through analysis to eclipse. At the height of his prestige he was idolized as the champion of enlightenment against the forces of obscurantism. In the period of analysis, English thinkers came to realize that they had little sympathy with a method that comprehended sensational knowledge. Locke carried this tendency to its consummation, for he saw the deficiency of Descartes' scientific ideas, and in attacking the doctrine of innate ideas, he indirectly attacked Descartes. While Locke passed on more of Descartes than he cut off, his explicit criticism spoke louder than his implicit assumptions, and the debt of English thought to Descartes went unrecognized for several generations.

It is pertinent, though not consequential, to refer here to the brief sketch by Woodbridge on "Locke's Essay", where Locke is described primarily as a moralist rather than as a logician or psychologist.

Concern with one man but in a more particular sense also characterizes Selsam's "Spinoza: Art and the Geometric Order" and Schneider's "Mill's Methods and Formal Logic". Selsam argues that Spinoza's philosophy possesses an intrinsic, an intellectual beauty, which is quite different from beauty of language or structural sym-

metry, and that Spinoza, though but little interested in formal esthetics, consciously adapted to his purpose a vehicle which so far from being a hindrance constituted a superb esthetic appeal and strengthened his arguments. Schneider uses Mill as a peg on which to hang an attack on the prevalent tendency to divide logic into compartments. He charges Mill with confusing the whole problem and condemns subsequent logicians for the evasion of the problems posed by their knowledge of Mill's confusion. While laboratory demonstrations are hard to state in syllogistic form, he says, the principles of evidence for deduction and demonstrative induction are the same; and the "detrimental" notion that there is a "difference between the reason of discourse and the reason of experiment" ought to be dispelled.

More comprehensive are the essays on "Coleridge" and on "The Pragmatic Naturalism of Chauncey Wright". In the first, Kagey attempts to appraise Coleridge's intellectual stature and his position in English philosophy. Sampling here and there, Coleridge reflected not mere eclecticism but "metaphysical clarity"; departing from the empiric tradition, he glimpsed if he did not formulate the theory of the concrete universal later developed by Hegel and incorporated in English thought by Green. Coleridge offered this solution for the "dichotomy which always separated universal from particular in empiricist logic", and it satisfied his desire to "reconcile the diversities emphasized by science and common sense with the unity demanded by faith, feeling, and ultimate metaphysical premises."

Wright, who has been credited with anticipating the pragmatism of James and the instrumentalism of Dewey, is considered by Kennedy in relation to Darwinism. Because of no great skill as a writer or teacher Wright failed to impress as wide a public as many of his contemporaries, although his intimates recognized the trenchant fibre of his mind. He quickly appreciated the intellectual perversion implicit in the Spencerian effort to fit scientific facts to Procrustean theology, and had he developed a pragmatic empiricism, "his formulation of it would have remained literally faithful to the canons of scientific truth".

Here we may summarize "An Empirical Survey of Empiricisms", in which Dewey relates the historic conceptions of experience, namely, the "collective memory" of the Greeks, the observational "experience" of Locke, and the experimental view now in process of development. These concepts are interpreted as expressing the *weltanschauung* of their times and as giving way one to another

because of inadequacy in the face of a more complicated world. Thus "collective memory" was discarded during the Enlightenment as causing bondage to the past; and Locke's concept ceased to satisfy thinkers aware of the new discoveries in science.

Baker's essay, "The Emergence of Space and Time in English Philosophy", also concerns itself with a diffused problem. Just as contemporary physics has revived discussion about space and time, the achievements of Galileo and Newton inspired an earlier English interest in the same question. On those foundations Henry More and others evolved a conception of space and time as "things", not merely as principles, and thereupon attacked seventeenth-century materialism.

Nagel's "Impossible Numbers": A Chapter in the History of Modern Logic" reflects a similar interest in the relation of science to philosophy. Prior to the nineteenth century mathematics was regarded as the science of quantity, yet when "negative" and "impossible" numbers began to turn up, mathematicians were in a quandary. In spite of the fact that these numbers, though absurd, were variously useful, many mathematicians rejected them as incompatible with mathematical quantities, but others began to grope toward a qualitative concept. After repeated stalemates mathematicians reached the conclusion that mathematical symbols were "capable of any number of different interpretations". Important among the explorers, most of whom appear to have been English, was Woodhouse who argued that since "imaginary" quantities lead to right conclusions, "they *must have a logic*", and Peacock who appreciated that " $a-b$ is significant in arithmetical algebra only when $a > b$." A few years later, by 1840, Boole, the systematizer but not the inventor of symbolical algebra, formulated the distinction between "pure" and "applied" mathematics.

In striking contrast to the rest of the volume is McClure's "Greek Genius and Race Mixture". In his effort to account for the genius of the Greek people and to formulate an ethnological approach to Greek philosophy, the author has been seduced into eight and a half pages of twaddle and misinformation. To say that the "doctrine of the mean" rests on the dual constitution of Greek character, the contemplative and the warlike, becomes thoroughly supposititious, not to say ludicrous, when it is recalled that one of the author's "peaceful" elements was aggressively warlike and that one of his "warlike" elements displayed a great love of art. Cnossus, the city of the "peaceful" Cretans was without walls not because the Cretans

were peaceful but because they inhabited an island and controlled the sea; in Asia Minor, the same racial stock fortified its cities. The Spartans, the "warlike" Dorian element among the Greeks, illustrated by their love of music that Greek love of beauty was not "essentially un-Greek".

Fortunately no other contributor has attempted to postulate theories on "facts" so doubtful. Several of the essays are unimportant, but others, noticeably those of McKeon, Hook, Lamprecht, and Nagel, deserve high praise. They are sound, they are well-written, and they suggest aspects of thought and methods of approach that will stimulate further investigations in the same or in related fields.

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*Department of History,
University of Missouri.*

MEAD, GEORGE H., *Mind, Self and Society*. Chicago: The University of Chicago Press, 1934. Pp. xxxviii+401.

The present volume represents the conceptual system of social psychology which the late Professor Mead developed in his lectures at the University of Chicago during the first 3 decades of this century. Professor Morris has edited students' notes and a stenographic copy of the 1927 course, and in an introductory essay he himself has contributed a very concise and readable résumé of Mead's psychology. Considerably more deletion, however, would have been desirable, since the constant repetition of *Leitmotiven*, often in almost identical form—a sound pedagogical device no doubt—bores the reader needlessly.

There is a nineteenth century flavor in this book, which attempts a cautious synthesis of pragmatism, behaviorism, evolution, and democracy. Each point is made by means of speculation or of homely anecdotes. Every idea—and there are about half a dozen distinct and good ones—is drained of all its possible implications before the author abandons it. This does not mean, though, that the modern psychologist can afford to dismiss Professor Mead with the usual derogatory term of "metaphysician". Any thinker nowadays who appreciates the interconnections that bind all knowledge together must be respected; and, while it may be true that too many readers will be able to interpret Mead's theories to fit their own preconceived notions, still it is not altogether improbable that a small few will be stimulated to grasp the social implications of their own research.

Mead's chief problem seems to have been to get society into the

individual through the doctrine of "social behaviorism" and then to analyze the continual process of interaction going on between the culture and the personality. According to his view, *minds* arose when in the course of evolution gestures, especially vocal gestures or language, became "significant symbols", i.e. symbols which "implicitly arouse in an individual making them the same responses which they explicitly arouse, or are supposed to arouse, in other individuals, the individuals to whom they are addressed". In like manner, the emergence of the *self* demanded interacting human beings who communicated through language, for it came into existence when the individual was able "to carry on a conversation of gestures with himself" and this in turn was possible only after participating in play and in games and after acquiring through experience the notion of "the generalized other", or "the attitude of the whole community". The author mixed this phylogeny with an informal ontogeny and seemed to imply an identification of the two. *Society*, therefore, "could not exist without minds and selves, since all of its most characteristic features presuppose the possession of minds and selves by its individual members; but its individual members would not possess minds and selves if these had not arisen within or emerged out of the human social process in its lower stages of development". When once the mind and the self have emerged, moreover, the personality is able to select his own environment and, in an ideal democracy, he secures self-realization through extending "the generalized other" to include more of his fellows.

The line of reasoning is obviously intricate and complicated. Whether the psychologist who has not been a member of Mead's esoteric and devoted followers agrees or disagrees with it does not matter, if he grows aware of certain problems within his own discipline. Even though Mead was usually concentrating upon the origins of culture and behavior, he unwittingly was calling attention to the importance of the social *milieu* as one of the never-to-be-forgotten variables in any psychological research. Even though he cast too many unproven aspersions on animal life, he was thus emphasizing the rôle of communication and language in society. And even though his romantic defense of democracy sounds feeble as guns begin to boom again in Europe, he was, perhaps, asking his colleagues to acknowledge the hope that psychology through the nature of its subject matter cannot avoid the ethical "shoulds" and "oughts" which a knowledge of human behavior must help to prescribe.

LEONARD W. DOOB.

Yale University.

EURICH, ALVIN C., and CARROLL, HERBERT A., *Educational Psychology*. New York: D. C. Heath and Company, 1935. Pp. vii+436.

One is impressed by the extensive quantitative and experimental background for the description and modification of human behavior represented in this new textbook on educational psychology. The book is devoted primarily to measurement, the interpretation of data, and to a summary of available knowledge about pupils in and out of school. While written for teachers and prospective teachers, the book is not a textbook of applied psychology in the sense of advocacy of teaching methods, and does not attempt to raise questions of value as represented in current educational controversies on objectives. Where questions of educational policy are involved, the typical procedure is to present the evidence for and against the issue with care not to overinterpret the data in terms of a point of view.

The book begins with an introduction dealing with general methods of investigation and the place of a functional educational psychology in the preparation of teachers. The logical order is interrupted by a chapter on reading and study habits, which reflects the importance of the problem, a desire to improve the practices of students using the text, and a special interest of the authors. Chapter III continues with a discussion of statistical techniques and is followed by chapters concerned with basic principles of measurement, aptitude tests, achievement tests, and the measurement of interests, attitudes, and personality. A chapter devoted to aesthetics reflects both the increase in breadth of educational goals and progress in research.

Six chapters are primarily concerned with the nature and causes of individual differences. Special treatment is accorded the gifted, the subnormal, and maladjusted child. The status of evidence on the differentiation of instruction is given in Chapter XIV. The volume is concluded with excellent chapters on learning, memory, and transfer of training.

One misses in the volume any consideration of the deductions from psychological facts underlying such innovating practices as the activity movement. Some will question the exclusion of the experimental data and point of view of the Gestalt psychologists or the brief treatment accorded emotional problems. These are conscious omissions in the attempt of the authors, as stated in the preface, to include the most practical and well established material and to avoid the speculative.

The text meets in an excellent way the needs of students in

courses in educational psychology organized as a part of the requirements for the teacher's certificate. Because of its scholarly character and its liberal provision of references, it should also prove serviceable in connection with survey courses on the graduate level for persons without recent experience in the field of educational psychology.

WILLARD C. OLSON.

University of Michigan.

CONKLIN, EDMUND S. *Principles of Adolescent Psychology*. New York: Henry Holt and Company, 1935. Pp. xii+437.

The purpose of this book is primarily to supply information concerning the difficulties of the "teen age". Clinical problems of adolescent behavior, about which many people intrusted with the guidance and care of adolescents have sought the advice of the author, serve as chief subject matter. The author states in the preface: "While I have sought generalizations wherever the literature of the subject made them safe, I find myself constantly thinking in terms of the point of view of the student leader, the parent, the dean, the teacher, the physician, the pastor, and the social worker who must use this knowledge for the interpretation of particular behavior problems."

Adolescence is defined as the period of growth after childhood has passed and before the full development of powers and abilities has been achieved. The treatment is in terms of changes of personality pattern in relation to growth changes occurring through adjustment to the world in which the growth itself occurs. In the text proper consideration is given to influences operating on the individual and to the resulting behavior. Physical maturation, sex differences, interests and ideals, social adjustment and social conflict, family influences, romantic love, religious adjustment, faults, misdemeanors and delinquency, and abnormalities of personality organization and adjustment are the problems discussed.

The book is in the main a delineation of problems or issues, rather than of principles, if principles are defined as experimentally proven uniformities. In the presentation of the problems there is some discussion of experimental work, but more of the material comes from the impressions and clinical observations of the author's wide experience.

The references, selected from the author's bibliographies of far more than two thousand titles, are given in footnotes. It is to be

regretted that those cited are only a small proportion of the original list and that they are presented in an inconsistent style, and often incomplete as to place, publisher, date, and pagination.

JOHN B. WOLFE.

Yale University.

CORNELL, ETHEL L., and COXE, WARREN W. *A Performance Ability Scale, Examination Manual*. Yonkers-on-Hudson, New York: World Book Company, 1934. Pp. iv+88.

The Cornell-Coxe Performance Ability Scale affords psychologists, clinical workers, and examiners a convenient new instrument for measuring performance ability apart from language comprehension and verbal response. The verbal bias in most intelligence tests implies that intelligence is synonymous with verbalization, and prevents their use with subjects linguistically inferior or non-versed in the language of the test. Experiments with performance material such as the Cornell-Coxe Scale demonstrate the practicability of measuring intelligence through non-verbal techniques and afford the less verbally talented individual an opportunity to exhibit his talents. The scale is appropriate for normal subjects from 7 or 8 years of age, and for subnormal adults of comparable mental age. It is appropriate for clinical work with speech-handicapped individuals, foreign subjects, and deaf mutes, and affords a serviceable check on subjects who score low for other reasons on verbal tests.

The Cornell-Coxe Performance Ability Scale is an extension and revision of the Army Performance Scale. In the revision, the authors have attempted to measure not special aptitudes such as manual dexterity or mechanical skill, but general intellectual responsiveness through performance material. The authors have employed the new instrument in testing the hypothesis of group factors underlying general concrete ability.

Varied criteria were used in selecting the items included in the scale. Items were selected that involved as many different kinds of content as possible, that were presentable in non-verbal fashion, and that measured a wide range of specific ability. After trying out a variety of materials the following items were retained in the final scale. (1) The manikin and profile from the Pintner-Patterson Scale. The administration of the test as in the army scale was retained, but scoring was changed. (2) Kohs Block Design. The 10 most discriminative items were retained and arranged according to difficulty. Extensive changes were made in giving and scoring the

test. (3) A picture arrangement test was devised by the authors similar to those of Decroly and Vermeylen. This test was found to correlate highly with the Healy Picture Completion Test used in the series and consequently may be interchanged for that test. (4) Symbol-digit test. In form this test is the same as that used in the army scale, but slightly different scoring directions are provided. (5) Memory for designs. Two of the original army designs that contributed little to diagnostic or discriminative value were eliminated and one easier design was added. The method of scoring the drawings was revised. (6) Cube Construction. The materials for this test were taken without change from the army series, but the administration and scoring were revised. (7) Healy Picture Completion Board II. This test in original form was retained, but with revised scoring.

Raw scores for the separate tests are transmuted into equated scores, the sum of which can in turn be converted into a mental age for computing an intelligence quotient. The standardization is based on tests of 306 school children in a wide age range, children who were referred for examination chiefly because of school retardation. Reliability was determined by repeating the test with 125 children after an interval of 11 months. The correlation between the first and second testing was .929. Statistical results indicate that the scale is not a substitute for other intelligence tests, but supplements them. Norms are tentative, but the authors believe that they would not be materially changed by the addition of more cases.

Included in the manual is case study material illustrating ways in which performance material contributes to the understanding of individual problems, and a study of comparative Binet and performance scores for subjects grouped in 6 categories on the basis of linguistic, environmental, and emotional qualities.

The authors have performed a commendable service in developing this new scale, and in furnishing new data relative to mental organization through their research studies with the material. Their contribution might have been larger still had they discarded more of the old materials and instead of borrowing and attempting to revise items from older scales had set about creatively to rethink the entire problem of performance testing. The number of cases on which the test was standardized is assuredly too small to guarantee adequate standardization throughout the entire age range, and the skewed selection of cases is of questionable value for the purpose.

The blank provided for recording and scoring responses is con-

venient, but lacks space for general observation notes. A history of performance testing, discussion of the uses of tests in psychological diagnosis, and interpretative material precedes directions for administering and scoring the tests. Although the discussion is interesting and instructive, it consumes valuable space in the forepart of the manual, and is scarcely comprehensive enough to be really helpful to the clinical examiner.

The Cornell-Coxe Performance Scale merits extended trial and experiment with a wider range and larger number of subjects to determine its value as an instrument in clinical psychology.

GERTRUDE HILDRETH.

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New York City.*

Révész, G. (Editor), *Acta Psychologica*, Vol. I, No. 1. The Hague, Holland: Martinus Nijhoff, 1935.

This most recent addition to the list of psychological periodicals is designed to afford a medium for the publication of representative researches from different countries, particularly those which represent distinct contributions to psychological theory. It is edited with the collaboration of 31 psychologists, representing 16 different countries. In order to avoid duplication of the functions of other journals the editors have announced their intention to give preference to manuscripts which are long enough to be published in monograph form, and to confine each number to one or possibly two such articles. Individual articles will consequently be available as separate publications. The first number departs somewhat from this plan, in that it contains the report of the Tenth International Congress of Psychology at Copenhagen in 1932.

R. B. MACLEOD.

Swarthmore College.

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REPORT OF THE ROUND TABLE ON "TIME LAG IN THE PUBLICATION OF PSYCHOLOGICAL RESEARCH"

AMERICAN PSYCHOLOGICAL ASSOCIATION, ANN ARBOR,
MICHIGAN, FRIDAY, SEPTEMBER 6TH—4:00 P.M.

JOHN E. ANDERSON, CHAIRMAN, UNIVERSITY OF MINNESOTA

This round table was well attended both by the editors of psychological publications and by others including many contributors to journals. There was much discussion.

The conference opened with a brief presentation by each editor of his views of the problem of lag. Emphasis was placed upon the following points on which contributors can assist in reducing lag. Some manuscripts come into editors' offices poorly prepared and with little or no indication that the author is familiar with the general style of the journal, the length and type of articles it uses or the methods of citation, reference, etc. It was felt that authors could contribute directly to the reduction of lag by preparing manuscripts with more care and with more definite knowledge of the purposes of the journals to which articles are submitted.

It was suggested that a circular of instructions for contributors be prepared for wide distribution to psychologists and reprinted at intervals in order that each oncoming group of contributors could become familiar with it. This circular should not only be concerned with details as were the "instructions"¹ prepared in 1929, but should also make concrete suggestions for shortening manuscripts. Among the points that might be included, the following were mentioned:

(1) The elimination of historical material and bibliographies or their reduction to a minimum. For instance in place of an historical summary reference might be made to the most recent BULLETIN article in a particular field followed by a few sentences which bring the historical material subsequent to the BULLETIN article up to date.

(2) The elimination of long and involved descriptions of appar-

¹ Instructions in Regard to Preparation of Manuscript. *Psychol. Bull.*, 1929, 26, 57-63.

atus and of the techniques of conducting experiments. Many methods are now so standardized that detailed descriptions are unnecessary.

(3) The elimination of formulae and of detailed descriptions of statistical procedures that are available in standard texts of statistics.

(4) The elimination of either tables or graphs in those instances in which both represent identical material.

(5) A statement that would substitute for the point of view now current, that to be scholarly an article must have an extensive analysis of the literature, the point of view that the primary business of a scientific article is a compact and succinct presentation of results, together with a limited amount of interpretative material.

It was also suggested that authors be encouraged to submit manuscripts to colleagues for specific suggestion on methods of condensation, since a second person can often point out possibilities not apparent to the original author.

Brief statements were made by the editors present of the amount of lag in their own publications. In general the time lag seemed to run from 9 months to 15 months. Some of the contributors present mentioned instances of a lag of as much as 25 months.

The point that a certain amount of lag improved the quality of the published material since it made possible a better selection of articles was made. If lag were entirely eliminated, the editor in order to meet conditions of publications, might be under the necessity of printing inferior articles.

It was pointed out that in the chemical journals announcement of important discoveries can be secured within 2 weeks or a month by a very brief publication in letters to the editor. For articles the average lag is 3 months. Formerly the average lag was 6 months. In part this reduction was obtained by a gradual education of workers in the field on the importance of reducing lag and in part by increased efficiency on the part of editorial boards. Manuscripts are referred by the editors to referees, who recommend acceptance or rejection. Unimportant articles, articles which have been published elsewhere, and translations are eliminated. Suggestions are frequently made for shortening articles. Definite attempts have been made to reduce historical material and descriptions of apparatus to a minimum. On the advice of psychologists the chemists and physicists have changed the page size and the type of their journals to secure maximum wordage per page and still preserve legibility. Printing is in double column like that used in the *Psychological Abstracts*.

Other methods of decreasing lag were mentioned. The great

difficulties encountered in introducing a special volume in the midst of a serial publication were described. The practice of securing publication in advance of the regular date by paying costs was discussed. The use of a section for short articles in smaller type to appear very promptly was mentioned. Many contributors when given the alternative of publishing an article promptly as a note in a special section prefer to wait for regular publication in larger type. Thus contributors when given a specific choice seem to be less concerned about time lag than they are in their general comments.

Attention was called to the possibility of a central agency to which all manuscripts could be submitted and then allocated to appropriate journals. Because of the fact that only a limited number of journals are under Association control or grouped under other specific agencies this procedure seemed to be impractical.

The experience of other scientific societies which met the problem of time lag by concerted action was cited. It seemed to be the sense of the conference that the American Psychological Association was not in a position to take drastic steps partly because it controls only a few of the journals and partly because Association journals are not the most serious offenders with respect to lag. The round table seemed to favor calling the attention of members and associates to the importance of meeting the problem of lag by shortening contributions. If this procedure were followed, in time a tradition that would improve present procedures might become established.

It was pointed out that the chief responsibility for cutting down lag does not rest upon the contributors but upon editors. Since the number of psychological contributions will inevitably increase, the lag will increase unless new journals are started. It was suggested that editors can assist in meeting the problem by:

- (1) Immediate reading of the manuscripts which are submitted.
- (2) Prompt decision as to whether the article has sufficient merit to crowd out another article.
- (3) If it has such merit, a decision as to the amount of space which can be allotted to it, followed by a letter to the author suggesting a space limit and indicating possibilities of condensation. If this procedure is to be effective, the editor must refuse to publish the article unless it is cut down.

The need in psychology of at least one journal like the *Proceedings of the National Academy of Sciences* which publishes only very short articles was stressed.

It was suggested that the problem of time lag be discussed in the

branches and sections of the American Psychological Association and that any suggestions developed be collected and transmitted to the responsible officers in the Association.

The following resolution was voted:

That it is the sense of this meeting that a reasonable time lag is both inevitable and desirable in order to maintain a high standard of quality in publication, but that the present lag is in some cases wholly unreasonable, and that a lag of more than 12 months between the receipt of an acceptable manuscript and its publication is unnecessary.

The round table closed with the passage of a resolution that a report of this meeting, together with the resolution just voted, be forwarded to the Board of Editors of the Association with the request that it study the problem of time lag in publication and make appropriate recommendations to the Council of Directors.

THE NEW PSYCHOLOGY UNIT AT HOWARD UNIVERSITY

BY F. C. SUMNER

Howard University

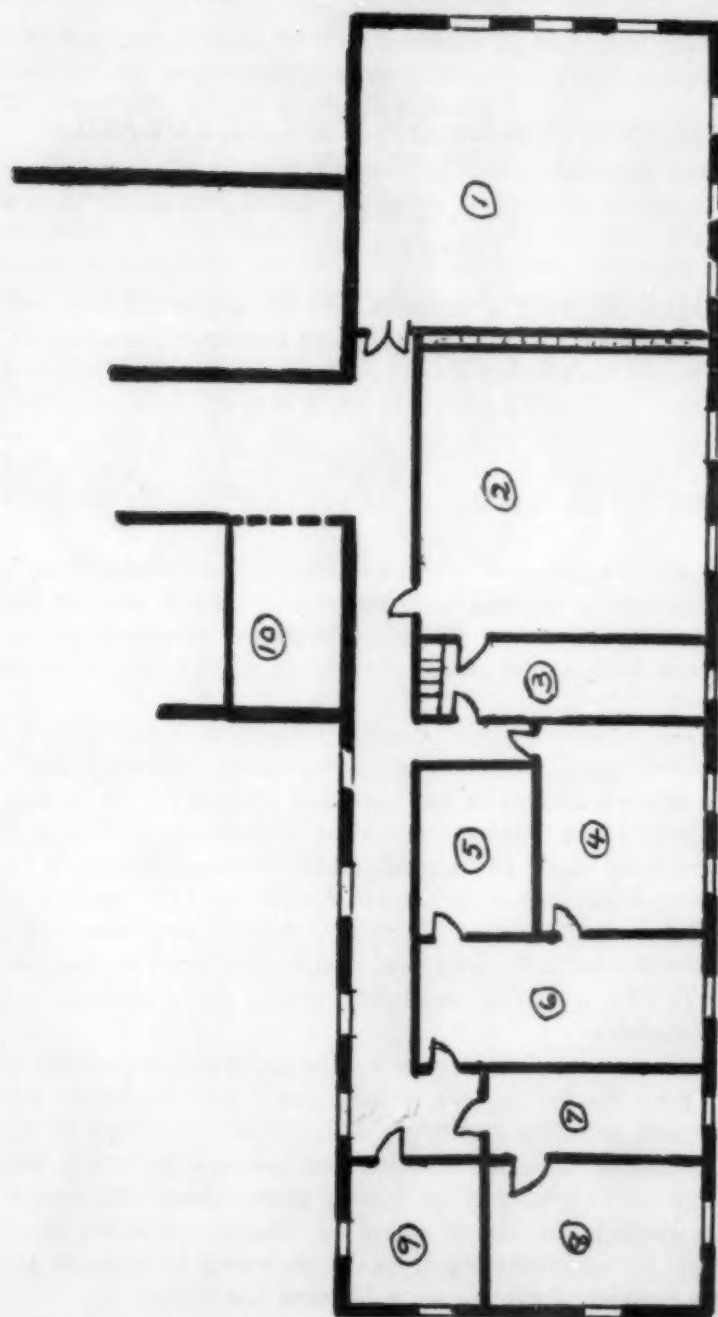
On April 30, 1935, a beautiful new classroom building was formally opened on the campus of Howard University, Washington, D. C. In style the building is early American or Georgian, trimmed in limestone. The central portion of this H-shaped structure is three stories high while the wings are two stories. It was designed by Albert I. Cassell and erected at a cost to the federal government of \$461,000 and has been named the Frederick Douglass Memorial Hall.

The special significance of this new building for psychologists is that it contains a spacious and modernly appointed unit for the psychology department at Howard University, consisting of the entire south wing of the second floor or of a floor area of 4,350 square feet.

This new psychology unit contains 9 rooms as indicated in the accompanying plan: (1) a large undergraduate laboratory which seats 30 students and which has concealed cabinets for the storage of apparatus; (2) a lecture room seating 48 students; (3) office of the departmental head; (4) a small lecture room and laboratory for graduate students; (5) a dark room furnished with a number of daylight lamps, work-benches, etc.; (6) a machine shop containing a metal lathe, a wood lathe, a jig-saw, electric drill, work-benches and tools; (7) (8) and (9) small laboratories for professors and graduate students.

The unit as realized is adequate for the psychology department at Howard for a number of years to come and is undoubtedly the first and only unit definitely and amply designed for psychology in any Negro institution of higher learning and compares favorably with psychology units in many of the leading institutions of the country.

Great credit is due Dr. Mordecai W. Johnson, president of the University, for countenancing from the beginning so adequate and modern a housing of psychology at Howard University.



PSYCHOLOGY UNIT
Douglass Memorial Hall, Howard University, Washington, D. C.

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

At its May, 1935, meeting, the Committee on Grants-in-Aid of the National Research Council made the following awards in the fields of anthropology and psychology: Fay-Cooper Cole, professor of anthropology, University of Chicago, "racial criteria in the study of hair"; Ernest R. Hilgard, assistant professor of psychology, Stanford University, "quantitative characteristics of the process of acquisition and extinction of conditioned responses in man"; William A. Hunt, assistant professor of psychology, Connecticut College, "behavioral response to a shot stimulus"; Theodore F. Karwoski, assistant professor of psychology, Dartmouth College, and Mason Crook, instructor in psychology, University of California at Los Angeles, jointly, "quantitative investigation of the sensitivity of the blind spot for spectral light"; Paul Kirchhoff, research associate in anthropology, Columbia University, "native agriculture in South America"; Karl F. Muenzinger, associate professor of psychology, University of Colorado, "analysis of the function of punishment in learning"; Sidney M. Newhall, Sterling fellow, Yale University, "imagery in recurrent vision"; Cornelius Osgood, assistant professor and curator of anthropology, Yale University, "study of the existing anthropological collections from the Athabaskan Indians of Canada and Alaska which have been deposited in museums of northeastern Europe, especially Russia"; Vincenzo Petrullo, field director for South American research, University of Pennsylvania, "ethnological studies of the Yaruro peoples in Venezuela".

There will not be another meeting of the Committee on Grants-in-Aid this year. The next meeting of the Committee will be held in March, 1936. Applications to be considered at this meeting must be on file with the Secretary of the Committee, Dr. Clarence J. West, not later than February 15, 1936.

NOTES AND NEWS

PROFESSOR JOHN F. DASHIELL of the University of North Carolina has been elected to the editorship of the *Psychological Monographs* to fill the place left vacant by the death of Professor Joseph Peterson.

THE Eleventh International Congress of Psychology will meet at Madrid, September 6 to 12, 1936.

DR. C. S. MYERS, principal of the National Institute of Industrial Psychology, London, has been elected an honorary fellow of Gonville and Caius College, Cambridge.

THE degree of doctor of laws was conferred on Dr. Madison Bentley, Sage professor of psychology at Cornell University, at the annual commencement of the University of Nebraska, from which he was graduated in 1895.

THE committee on scientific Research of the American Medical Association has made a grant to the American Institute for the Deaf-Blind for the purpose of enabling it to investigate the question of an independent vibratory sense. The work will be carried on under the direction of Robert H. Gault, professor of psychology, and A. C. Ivy, professor of physiology, both of Northwestern University.

THE Social Science Research Council has announced the award of 8 pre-doctoral fellowships for graduate study. These fellowships provide \$1000.00 and tuition charges; and are designed to aid exceptionally promising students of the social sciences to obtain research training beginning with the first year of graduate study. Fellows are required to devote their full time to graduate study, in some other institution than that in which they received their undergraduate training. The fellowships will be offered again for the academic year 1936-1937. The closing date for the receipt of applications on blanks to be secured from the Fellowship Secretary is March 15, 1936. Inquiries should be addressed to the Social Science Research Council, 230 Park Avenue, New York City. Each candidate must submit a letter, in support of his application, from the chairman of the department in which he has pursued his major undergraduate study, before the blanks will be sent to him. Among the appointees for 1935-1936 was Irvin L. Child, A.B., University of California at Los Angeles, for study in psychology at Yale University.

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